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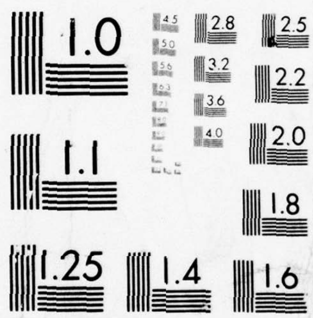

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SEAKEEPING CHARACTERISTICS OF A PRELIMINARY DESIGN FOR A SEA LOITER AIRCRAFT

by

Alvin Gersten
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FEBRUARY 1977 SPD-748-02

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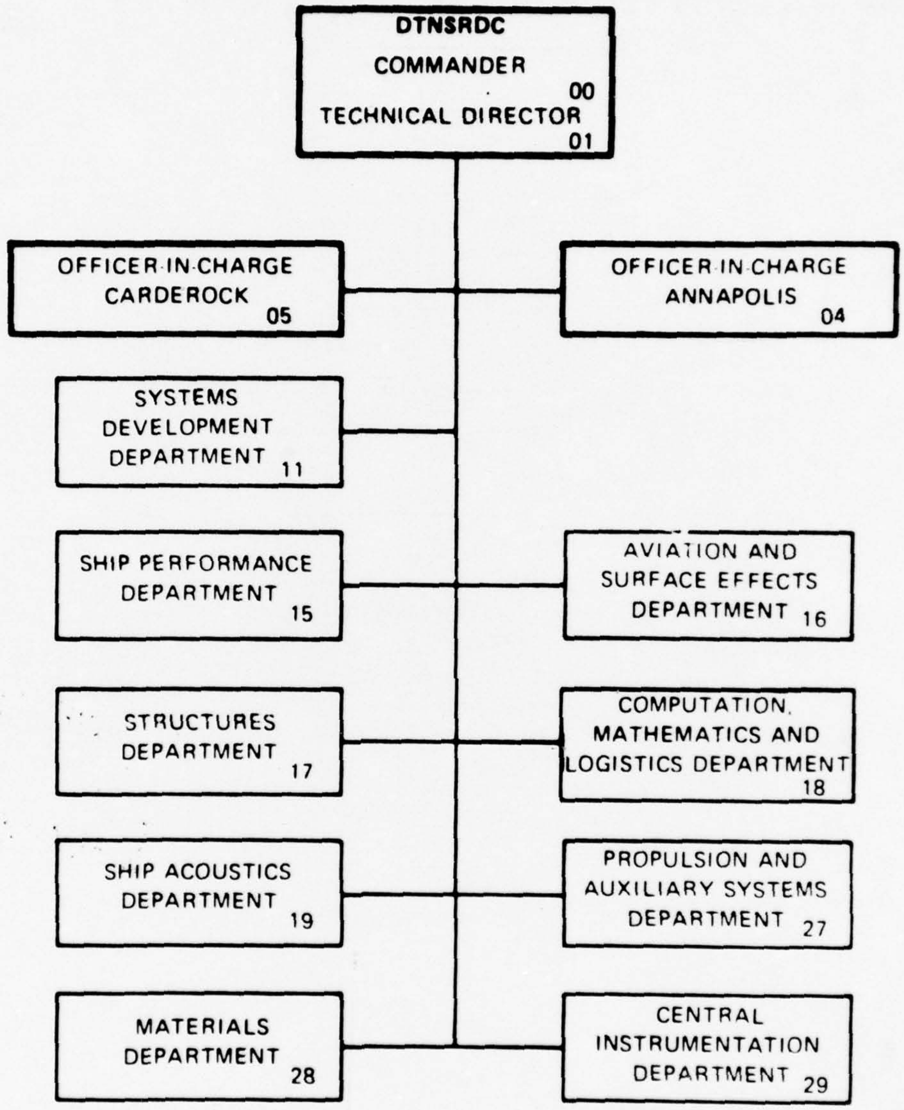

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A model of a proposed sea loiter aircraft has undergone experiments in the hullborne mode at various headings to regular and random waves. The principal goal of the investigation was to provide data for evaluating the habitability characteristics of this concept. The results will also be used to validate computer predictions. Transfer functions are presented in this report, as are plots and tables of standard deviation values and significant values of vehicle response in a seaway. The effect on motions of varying model weight, and the

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effectiveness of damping plates in reducing motions are discussed. In general, neither of these is found to significantly alter the unusual transfer functions obtained for this craft. The motions of a buoy, whose configuration was selected to provide wave surface following characteristics, and which was also subjected to waves in the towing tank, are discussed in an appendix.

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ABSTRACT

A model of a proposed sea loiter aircraft has undergone experiments in the hullborne mode at various headings to regular and random waves. The principal goal of the investigation was to provide data for evaluating the habitability characteristics of this concept. The results will also be used to validate computer predictions. Transfer functions are presented in this report, as are plots and tables of standard deviation values and significant values of vehicle response in a seaway. The effect on motions of varying model weight, and the effectiveness of damping plates in reducing motions are discussed. In general, neither of these is found to significantly alter the unusal transfer functions obtained for this craft. The motions of a buoy, whose configuration was selected to provide wave surface following characteristics, and which was also subjected to waves in the towing tank, are discussed in an appendix.

ADMINISTRATIVE INFORMATION

The investigation discussed herein was funded by the Advanced Naval Vehicles Concepts Evaluation Program, Task Area S0407000, Element 63564N.

INTRODUCTION

One of the nine generic vehicle concepts being evaluated under the Advanced Naval Vehicles Concept Evaluation (ANVCE) Project is a sea loiter aircraft. This vehicle should be capable of maintaining station for extended periods of time while hullborne at zero or low speed. It must then transit to other sites at 300 to 400 kts. This capability would make it well suited for rapid deployment during an anti-submarine warfare operation.

The ANVCE program was set up within the Chief of Naval Operations Office and assigned the task of expanding the data base for the selected advanced vehicle concepts[1*]. The program must also examine the military worth, technical feasibility and cost of these concepts. After carrying out state-of-the-art assessments, analyses and model experiments are being conducted to fill in the technological gaps. One goal is a hull design for the sea loiter aircraft that has acceptable take-off resistance, adequate stability, reasonable landing impact loads, and--most pertinent for this investigation--is habitable when loitering on the sea. It is anticipated that the limiting condition to operation in rough seas will be based on the tolerance of the crew to the pounding and high acceleration levels. The estimated minimum capability required is Sea State 4 operation, so that the seaplane can perform its mission roughly 50 percent of the time throughout the year.
At present it is not known whether the aircraft will be relatively small or as large as a C-5A. Retractable vertical floats could be incorporated

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*References are listed on page 31.

to raise the craft out of the water, thereby reducing the hull volume on which waves could act, and consequently reducing vehicle motions.

Although the size and hull form of the seaplane have not been finalized, one preliminary configuration was selected by the sea loiter aircraft "Advocate Office" for use in seakeeping experiments. It was requested that both random and regular wave responses be investigated on this design. Regular wave experiments are useful for deriving transfer functions that can be used to validate computer predictions. This avoids the possibility of poor correlation due to differences in statistical samples. Random wave experiments permit direct determination of responses in a given sea state.

The first phase of experiments was conducted at the David W. Taylor Naval Ship Research and Development Center (DTNSRDC) in September 1976 to determine the effect of displacement, speed (low values) and heading (head, following and beam seas) on motions and accelerations.* The second phase was carried out in November 1976 to look at the effectiveness of damping plates in reducing motions--particularly roll. During this phase a large number of headings was examined. The results of these two groups of experiments are presented in this report.

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*During this phase a ring-shaped buoy was also tested to evaluate its surface following characteristics (see Appendix).

DESCRIPTION OF MODEL AND TEST EQUIPMENT

MODEL

The seaplane hull had circular sections, no step, and was rather stubby (length/beam = 5). The wings on the model were not aerodynamically shaped since they were needed only to support floats and/or damping plates, and for obtaining a proper mass distribution--not for providing lift. They were made with a rectangular cross-section to reduce cost. A T-tail with a rectangular cross-section was also provided along with a cockpit fairing up forward. Figure 1 shows these features. The wing tip floats also had circular sections; they were rounded at the front, and tapered to a point at the aft end. Their length was 36 in. (91.4 cm) and maximum diameter 7.2 in. (18.3 cm).

The hull was fabricated mainly from fiberglass but it had wood frames. The wings and empennage were also made from wood. Removable hatches were provided near the bow and stern for installing ballast weights. A hull opening and interior platform located at the longitudinal center of gravity were used for attaching the tow gear used during Phase I (see Figure 1) and for installing transducers. The opening was centered 46.8 in. (118.9 cm) aft of the bow.

Damping plates were mounted on the model during most of the Phase II experiments. Two sizes of these aluminum plates were evaluated--one matched set of two at a time: the small ones were 4 in. (10.2 cm) square and 1/8 in. (0.32 cm) thick; and the large ones were 6 in. (15.2 cm) square and 1/8 in. (0.32 cm) thick. Figure 1 shows one damping plate installed. They were mounted 19.5 in. (49.3 cm) below the bottom of the wing, 3 in. (7.6 cm) aft of the wing leading edge, and 50 in. (127.0 cm) from the hull centerline.

Table 1 lists some particulars for the model. Two displacements [330.0 lb (149.7 kg) and 264.0 lb (119.8 kg)] were examined during Phase I. The same moments of inertia were established for pitch and roll, and kept constant for both displacements. One displacement [327.0 lb (148.3 kg)] was investigated in Phase II; this was very close to the heavy displacement of Phase I. Moments of inertia were much different in Phase II than they were in Phase I: as shown in Table 1, the pitch value was increased and the roll value decreased.

The natural periods listed in Table 1 were derived from free oscillation experiments. The pitch period was slightly longer in Phase II* than in Phase I because of the increase in pitch moment of inertia; conversely, the roll period decreased mainly because of the decrease in roll moment of inertia. The heave period did not change significantly.

TEST EQUIPMENT

During Phase I the towing gear was mounted on the end of the carriage. Figure 2 shows the general arrangement of the model and towing gear: the model was free in pitch, heave and roll, and completely restrained in yaw, sway and surge. Heave was limited to ± 8.5 in. (± 21.6 cm) because the heave staff would "bottom out" if this range was exceeded. The model scale ratio was so small that equivalent Sea State 4 waves generated in the tank were quite large, resulting in an occasional heave motion to the limit of the heave staff.

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*These were measured without damping plates installed.

High resolution potentiometers were used for measuring pitch, heave and roll motions (see Table 2). Angular rates and linear accelerations were also measured. Drag was measured with a "block gage" which is a cube-shaped module containing flexures and a differential reluctance sensing element. The gage was installed in the heave staff directly above the gimbal. An ultrasonic transducer was used for the measurement of wave height. The wave probe was located as follows:

- For head and beam sea headings: 8.1 ft (2.5 m) forward of the model's CG and 3.3 ft (1.0 m) to starboard of its centerline
- For following sea headings: 0.5 ft (0.2 m) aft of the model's CG and 3.0 ft (2.4 m) to starboard of its centerline.

Model speed was measured by means of a wheel on the carriage which rode on a rail and drove a tachometer generator.

The experiments were conducted in the Maneuvering and Seakeeping Basin (MASK) at DTNSRDC. This towing basin is 360 ft (109.7 m) long, 240 ft (73.2 m) wide and 20 ft (6.1 m) deep. Pneumatic-type wavemakers on adjacent sides of the tank can be electronically controlled to generate long-crested regular waves, long-crested random waves having a preprogrammed spectral shape, and programmed short-crested waves or mixed sea and swell. Wave absorbers are installed along walls opposite the wavemakers, and these appreciably reduce the energy in reflected waves. The length of the basin is spanned by a bridge with tracks attached to its underside, along which the controlled model towing carriage runs. The bridge is supported on a rail system that permits it to rotate through angles up to 45 degrees from the longitudinal centerline of the basin. By using combinations of change

in model heading relative to the carriage, bridge rotation, and choice of wavemaker bank--and considering model symmetry--all angles between the direction of seaplane travel and wave propagation can be investigated.

Because the heave staff bottomed out occasionally during Phase I, and only zero speed was required for Phase II, the latter experiments were conducted in the MASK with the model not attached to a towing gear. A photograph of the test setup is shown in Figure 3. Light lines were attached to the model and kept slack, except occasionally to bring the model back to its proper orientation relative to the waves.

Motions were measured by means of ultrasonic transducers and gyros (see Table 2). Angular rates and accelerations were also measured as in Phase I. For possible use in structural design, wing tip acceleration was added. Figure 1 shows the transducer locations for Phase II.

The transducer signals were amplified and recorded on digital magnetic tape, with control provided by a digital computer system which included, among other things, an Analogic analogue-to-digital converter. Recordings were also made in analogue form on paper strip chart and analogue magnetic tape.

The Interdata Model 70 computer with 64 KB memory provided real-time digitization of all signals and immediate (post-run) data processing of wave inputs and vehicle responses. Peripheral equipment consisted of a nine-track Kennedy 3110 digital tape drive, an ASR-33 teletype, a Versatec 1100A Matrix 600 line-per-minute printer, and a Tridata 1024 cartridge tape recorder. While sampling, data summations used at the end of each run to

calculate mean and standard deviation for each channel were retained in memory. In addition, all data were calibrated in volts and written on the digital tape (see flow chart in Figure 4).

Video tape recordings were made of all runs, and 16 mm color movies were taken of selected runs.

DATA REDUCTION AND ANALYSIS

For regular wave runs, the mean ("d.c. level"), standard deviation and root Q_0 ($\sqrt{2}$ times standard deviation) were calculated after each run for all channels. In addition, harmonic analysis was carried out on the carriage after completing each regular wave run. This included determination of frequency of wave encounter, wave characteristics (maximum slope, length, celerity, etc.), and single amplitude and phase of model responses for the fundamental and first and second harmonics. The amplitudes and phases were obtained by means of a Fourier analysis; the Fourier amplitudes were then used to calculate transfer functions.

During Phase I the random wave on-carriage analysis also produced the mean, standard deviation and root Q_0. In Phase II the significant double amplitude was substituted for root Q_0. A zero-crossing routine was used to determine the number of cycles of wave encounter.

After the experiments were completed, spectral analysis and time-domain analysis were carried out for all random wave runs, or groupings of runs for the same condition which were treated as one long sample. The DTNSRDC Control Data Corporation 6700 computer and Stromberg Carlson 4060 (SC 4060) plotter were used for these analyses. Spectra and histograms were generated by the DTNSRDC "Power Spectra, Histograms, and Fourier Transforms" (PSHAFT)

program in conjunction with the "General Printing and Plotting" (GPP) program. In addition to plotting spectra and histograms, response amplitude operators (RAO's) and non-dimensional transfer functions were plotted by the SC4060.

Resolution for the spectral analyses was selected so that at least 40 degrees-of-freedom (DOF) would result. DOF is defined by

$$DOF = \frac{2 \cdot \text{number of data points}}{\text{number of lags}} + 0.5$$

The calculation of auto-correlation function in PSHAFT allows for a maximum of 60 lags (these are analagous to frequencies in the FFT procedure).

TEST PROGRAM AND PROCEDURE

As noted in Table 1, two model displacements were investigated during Phase 1. Experiments were first run in low regular waves to obtain transfer functions for the head and beam sea conditions at zero speed. Some runs were then made in higher regular waves in which the frequency of wave encounter was equal to the value required for maximum pitch and heave response. For these experiments, model speeds of 0, 0.89 and 1.79 kts and headings of head, beam and following seas were investigated.

Subsequent random wave experiments were conducted in Sea States 2 and 3 for head and following seas and Sea States 1 and 2 for beam seas. A reduction in sea state was necessary in beam seas because the model was in danger of swamping in more severe waves. Model speeds examined were again 0, 0.89 and 1.79 kts. In addition, confused sea runs were made at zero speed with a random Sea State 2 being encountered from ahead and regular waves (swell) being encountered from abeam.

During Phase II, one model displacement was examined and experiments were conducted with and without damping plates installed. Transfer functions were derived for the head and bow sea conditions by performing runs in regular waves at zero speed. Either no damping plates or the large damping plates were employed.

Most of the random wave experiments were carried out at zero speed in Sea States 1, 2, 3, and 4. Headings ranged from head to following seas in 30 deg increments. Sea State 4 was not generated for 90 deg (beam), 60 deg and 120 deg headings because these conditions appeared to be too severe for the model to survive. Generally, both sizes of damping plates were evaluated and runs were also made without damping plates. Experiments were also performed in mixed sea and swell; just as in Phase I, the seaway approached the model from ahead and the swell from abeam. Sea States 2, 3, or 4 were generated, and a swell length yielding severe roll response or moderate roll response [30.0 ft (9.1 m) and 12.6 ft (3.3 m), respectively]* were encountered simultaneously. The model had either no damping plates or one of the two available sets of damping plates installed.

Samples of spectra representing the energy distribution of waves in the towing tank are given in Figures 5a through 5c. A typical value of significant wave height is given on each figure; however, this statistic was somewhat different for each run in a particular sea state. For most random wave conditions sufficient run time was allowed to have the model encounter about 200 waves; this size sample should provide a good representation of the population. In regular waves, only one pass for a minimum of ten

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*Based on the roll transfer function.

cycles of wave encounter was obtained for each condition since the model response is essentially repetitive from one cycle to the next.

A summary of comments relative to changes in instrumentation setup, transducers, etc. is contained in Table 3.

PRESENTATION AND DISCUSSION OF EXPERIMENTAL RESULTS

TRANSFER FUNCTIONS FROM REGULAR WAVE EXPERIMENTS

Transfer functions were derived from data obtained during regular wave runs. A sample computer printout obtained from real-time computer analysis is shown in Figure 6a. Some of the items listed in the heading are:

FE, ωE	=	frequency of wave encounter
FO, ωO	=	wave frequency
TE	=	period of wave encounter
TO	=	wave period
LAMBDA	=	wave length
CELERITY	=	speed of wave propagation.

Mean, standard deviation and root Q_o values for motions, rates and accelerations are tabulated. A harmonic analysis, showing the fundamental, and first and second harmonics is contained in Figure 6b. Nondimensional transfer function (TRN FUN) values listed in Figure 6b were calculated from values of the fundamental, and are defined in the following way using single amplitudes of response:

a. angular displacement measurement: angle/θ

b. linear displacement measurement: displacement/r

c. linear acceleration measurement (in G's): acceleration $\cdot\ g/\omega_e^2 r$

d. angular rate measurement (in deg/sec): rate x $\lambda/360\omega_e r$

where: θ = maximum wave slope

r = wave amplitude

ω_e = measured frequency of wave encounter

λ = wave length

g = acceleration due to gravity (32.2 ft/sec^2)

Transfer functions were also calculated by using the root Q_o values. Nondimensionalization of pitch and heave was done in the same way as described above for Figure 6b; however, linear accelerations and angular rates were nondimensionalized in a slightly different way:

a. linear acceleration measurement (in G's): acceleration x $L/2r$

b. angular rate measurement (in deg/sec): rate x $L/C_1\omega_e 2r$

where: C_1 = 57.3 deg/rad

L = model length = 8.0 ft

Single amplitudes of responses were again used.

Figure 7 contains plots of the transfer functions obtained from Phase I root Q_o values. They pertain to the head sea condition with the seaplane model hove-to. Both displacements investigated are represented. The pitch curves in Figure 7a appear to reach a peak at a frequency of about 3.0 rad/sec. This is very different from the natural frequency of 6.7 rad/sec obtained from free oscillation tests in water (see Table 1). In fact, at the natural frequency the transfer function indicates that pitch response would be quite small. This phenomenon occurs for several modes of motion, and could be due in part to the wings contacting the water during wave experiments while

they do not during calm water oscillation tests. The curves for the heavy and light displacements are similar in a gross sense; however, the light displacement curve does exhibit a small dip at 4 rad/sec which is not present in the other curve. This undulation is also present in several other transfer functions, as will be seen later. The pitch curves are somewhat like those for a harmonic oscillator since a break frequency exists beyond which the normalized response is highly attenuated. However, the magnification factor does not approach unity at low frequencies for the heavy displacement.

The heave transfer functions also tend to reach a peak--although not a pronounced one--at approximately 3.0 rad/sec (see Figure 7b). The magnification is less than that for pitch and the response is similar to that for an over-damped system. However, in this case the curves tend to increase again as frequency is reduced below 2.0 to 3.0 rad/sec. Although the free oscillation tests indicate the heave natural frequency is roughly 6.0 rad/sec, there is very little heave response at that frequency.

Figures 7c and 7d give the cabin acceleration and heave acceleration transfer functions, respectively. Both of these exhibit a higher peak for the light displacement. In addition, cabin acceleration levels are significantly higher than those at the CG. A portion of the heavy displacement curve in Figure 7c is drawn dotted because there is a paucity of data points to define the curve, and subsequent, more complete Phase II results indicate that the peak shown at 5.0 rad/sec is actually a low point surrounded by peaks on either side.

The pitch rate transfer function is presented in Figure 7e. The low point in the curve for light displacement at 4.0 rad/sec matches that present in the pitch motion plot (see Figure 7a). However, for rate the

high frequency peak is predominant rather than the low frequency peak which is larger for motion.

Beam sea transfer functions from Phase I are contained in Figure 8. The roll response in Figure 8a is like that of an underdamped spring-mass-dashpot system except possibly at low frequencies where the curves should approach 1.0. Just as for the other Phase I transfer functions, the spacing of data points is such that fluctuations could exist in the curves between points. The response peaks at an average of 2.9 rad/sec for the two displacements which is far removed from the natural frequency of roughly 5.8 rad/sec obtained by free oscillation. Larger peak rolling motions occur at a slightly lower frequency for the lighter displacement.

The normalized heave response for beam seas is unusual and much different from its head sea counterpart. A peak occurs in both cases at approximately 3.0 rad/sec, but whereas in head seas the response drops off with increase in frequency, in beam seas heave ultimately increases with either an increase or decrease in frequency.

In beam seas, cabin and heave accelerations increase monotonically from low to high frequency (see Figures 8c and 8d). The effect of displacement on acceleration is small.

The roll rate transfer function is the last one plotted from Phase I results; it is presented in Figure 8e. Data points for both displacements indicate that a minimum occurs at a frequency of 3.7 rad/sec and then peaks occur with either a small increase or decrease of frequency. Further increase or decrease in frequency causes a dropoff in nondimensionalized roll rate.

Transfer functions derived from Phase II head regular wave experiments are presented in Figure 9. These are based on root Q_0 values, and are non-dimensionalized in the same way as the Phase I results. Because a closer spacing of points (more wave lengths) was obtained than for Phase I, it is possible to pick up some unusual fluctuations in the seaplane response. These may be due to the fact that the wing tip floats and particularly the wings themselves were immersed in the water for certain wave lengths but not for others with higher or lower frequency. Just as in Phase I, the natural frequencies obtained from free oscillation tests are far removed from their respective frequencies for maximum motion. Whereas during Phase I model displacement was varied, in Phase II the principal model configuration variable was the use of either no damping plates or one of two pairs of damping plates (see section on model description). The transfer function plots compare only the large damping plate and no damping plate configurations because the plates generally had no significant effect on the vehicle's response.

The head sea pitch transfer function in Figure 9a exhibits a sudden decrease to a minimum of 0.64 at a frequency of 4.2 rad/sec; this lies between two maxima of about 1.26 on the ordinate scale. There is also a rapid increase in response at the lowest frequency investigated, namely 2.0 rad/sec. For an underdamped system the response would go to 1.0 at low frequency. Although the transfer function is not like those obtained for most simple floating bodies, the repeatability of points for the two conditions shown lends credence to this faired curve as well as others to follow.

Heave response is given in Figure 9b. Two peaks are in evidence with the larger one occurring at 3.5 rad/sec. At the low frequency end, the curve rises to a third, higher maximum greater than 1.0.

The Phase II head sea cabin acceleration transfer function (Figure 9c) looks different from the corresponding Phase I curve shown in Figure 7c. This could be due, in large measure, to the few data points in the Phase I plot for frequencies above 4.0 rad/sec. For example, the point shown as a maximum at ω_e = 5.0 rad/sec for the heavy displacement in Figure 7c could actually be a minimum point between two maxima as shown at that same frequency in Figure 9c. The unusual nature of these responses indicates that a very close spacing of data points is needed to accurately define the transfer functions.

Heave acceleration--although much less severe than cabin acceleration, also has a minimum nested between two peaks; this null point occurs at a slightly lower frequency than the one for cabin acceleration, namely 4.2 rad/sec. As can be seen in Figure 9e, the pitch rate transfer function has several maxima and minima, with the largest peak occurring at 4.7 rad/sec.

In Figure 10 we find comparisons of Phase I (heavy displacement) and Phase II (no damping plates) transfer functions. The model weight is almost the same for the two cases shown. For the most part, although the curves are similar at their high and low frequency extremes, the Phase II plots fluctuate more at intermediate frequencies. Much of this fluctuation was not picked up during Phase I because, due to carriage time limitations, fewer data points with a wider spacing were obtained then.

In Figure 10c (taken in part from Figure 7c) it is clear that what appears to be the peak of the Phase I response curve is actually a minimum between higher and lower frequency peaks.

Nondimensionalized response plots for bow seas (30 deg off head seas) were also prepared, and these are shown in Figure 11. The pitch and heave responses (Figures 11a and 11b, respectively) have the same basic characteristics as the head sea curves from Phase II, but there are differences in detail. For example, the bow sea pitch transfer function does not have a minimum at ω_e = 4.2 rad/sec as there is in the head sea plot. Cabin acceleration and heave acceleration per unit wave amplitude (Figures 11d and 11e) are dissimilar in that the latter has two distinct peaks whereas the former does not; however, the major peaks do fall at about the same frequency. Pitch rate and roll rate responses (Figures 11f and 11g) reflect the pitch and roll responses, with the lower roll displacement curve yielding a lower roll rate, and conversely for pitch. At low frequencies the nondimensionalized rates go to zero whereas the displacements appear to approach 1.0.

REGULAR WAVE RESPONSES AS A FUNCTION OF SPEED

Regular wave responses in dimensional form are presented as a function of model speed (range 0 to 1.8 kts) in Figure 12. Wave height, heading and displacement are parameters in these plots, and frequency is essentially held constant--being approximately 3.2 rad/sec in head and following waves and either 3.2 rad/sec or 2.6 rad/sec in beam waves, depending on the wave length generated.

Figures 12a and 12b show that in head seas there is a tendency for pitch to decrease with a small increase in forward speed. The effect of displacement and heading on pitch is generally small and not consistent. Heave decreases with speed in following seas (see Figures 12c and 12d), but in head seas there is no significant change with speed. Heave is also greater in head waves than it is in following waves.

In Figures 12e and 12f for cabin acceleration there is generally no significant speed effect. However, there is some indication of a decrease in acceleration with speed for the heavy displacement in the higher following waves. The cabin accelerations are almost always less severe in following seas than in head seas.

CG acceleration (Figures 12g and 12h) generally increase a small amount with speed in head seas. It decreases slightly with speed in following seas, except for the higher following waves in which case the decrease is substantial. The change in displacement does not appreciably alter CG accelerations for most conditions; however, for the higher waves in head seas the accelerations are significantly greater for the heavy displacement. Here again, CG accelerations are usually lower in following waves than head waves--partially because of the lower frequencies of wave encounter.

Figures 12i and 12j show pitch rate decreasing slightly with increasing speed in most cases. The effect of displacement and heading on pitch rate is small and inconsistent.

RANDOM WAVE RESPONSES

Sample Computer Printouts

An example of the output from on-carriage reduction and presentation of data from individual random wave runs is given in Figure 13. In those cases of a forward speed condition where several passes were needed to get an adequate data sample, the runs were grouped together and then re-analyzed with the grouping treated as one long sample.

A sample of the output obtained on the CDC 6700 computer after the experiments were finished is presented in Figure 14. The coherency function listed under "Cross-Spectra" on sheets b to d of Figure 14 is defined by

$$\text{Coherency} = \frac{|S_{xy}(\omega_e)|^2}{S_x(\omega_e)S_y(\omega_e)}$$

where: $S_{xy}(\omega_e)$ = magnitude of the cross-spectral density function at frequency ω_e

$S_x(\omega_e)$ & $S_y(\omega_e)$ = magnitudes of the two auto-spectra being considered.

For the ideal case of a constant parameter, linear system with a single, clearly defined input and output, the coherency will be unity. For example, the coherency function for pitch and pitch rate is very close to 1.0 over the entire frequency range (see Figure 14 - Sheet s).

The 5 percent amplitude ranges given on sheets g through j of Figure 14 indicate the bandwidth for which the individual spectral ordinates do not get smaller than 5 percent of the peak spectral ordinate. Where two distinct peaks occur in the spectrum with a sharp drop in between, two 5 percent amplitude ranges are given. The nondimensional transfer functions are

defined in the same way as for the Interdata computer printouts.

The time domain analysis results begin on sheet k of Figure 14. Tabulations of the histograms are shown on sheets l through o where the heading "Data Points" refers to individual points on the time-history, separated in time by 1/sample rate.

The computer plots begin on sheet p of Figure 14 with auto-spectra, response amplitude operators (RAO's), and nondimensional transfer functions. The RAO's are obtained by dividing response spectral ordinates by wave spectral ordinates. Statistical values obtained from the spectral analysis are shown on the left-hand side of these figures. The statistic labeled as "APP" (apparent) is the average of the highest one-tenth double amplitudes. Statistical values are also given on the histograms which start on sheet u; these are derived from direct time domain analysis of the signals.

Standard Deviation of Motions, Accelerations and Rates

The standard deviation (root-mean-square about the mean) of seaplane model response from Phase I random wave runs is presented in Figures 15 and 16 as a function of speed. They are also provided in Table 4 so that exact values can be extracted if this is desired. Results for Sea States 2 and 3 and headings of head, following and beam seas are contained in these figures and tables. Figure 15 and Tables 4a and 4b show that motions such as pitch and heave do not vary much with speed over the range investigated. However, pitch rate and the accelerations do increase with speed in head seas--to a large degree because of the increase in frequency of wave encounter. The effect of displacement on model responses is usually small.

The maximum standard deviation, σ, of cabin acceleration in a head Sea State 2 at 1.79 kts is roughly 0.18 G's; in head Sea State 3 this increases to 0.24 G's at the same speed. These are fairly severe acceleration levels. At zero speed, conditions improve quite a bit with σ values for cabin acceleration dropping to 0.08 G's in Sea State 2 and 0.1 G's in Sea State 3. Figure 16 indicates that accelerations are slightly less in following seas when hove-to, and decrease further to about 0.03 G's when underway at 1.79 kts.

Table 4c contains σ values for roll and roll rate in beam seas at zero speed. During the experiments, the wave height was usually set lower for runs in beam seas because the model tended to get swamped at this heading to the waves. In spite of the lower wave height, accelerations are more severe in beam seas than they are in a head Sea State 2 when the model is hove-to.

Figure 16 shows that heave remains essentially constant with speed increase in following seas, pitch decreases slightly, and pitch rate and accelerations decrease significantly. The effect of displacement on responses is again small.

Figures 17 and 18 give standard deviation values of model response as a function of heading from Phase II random wave runs. The exact values can be obtained from Tables 5 through 11. The reader should note that 180 deg represents head seas and 0 deg following seas. The wave height was lowered for headings of 90 deg (beam seas) in the lower sea states (Figure 17) and 60 to 120 deg in the higher sea states (Figure 18) because of the model's inability to survive more severe waves at these headings.

Nevertheless, the wave heights shown for those cases do fall in the mild region of the designated sea states. In head Sea States 1 and 2, the waves were also low because of an improper setting of the wavemaker.

The effectiveness of the damping plates in reducing motions is small in random waves just as it was in regular waves. One possible exception occurs for roll and roll rate in a Sea State 3 coming from abeam (see Figure 18). Pitch and pitch rate are always lower at headings of 60 and 120 deg in Sea States 2 and 3 than they are at other headings. They also seem to be low in a head Sea State 2, but this is because the wave height is lower than for the other headings. Heave appears to be rather insensitive to heading; the variation shown is primarily due to changes in wave height. Roll is as severe in bow and quartering seas as in beam seas--particularly in the range of 60 to 120 deg headings.

Significant Double Amplitudes of Motions, Accelerations and Rates

Significant (average of the highest one-third) values of peak-to-peak model responses from Phase I are plotted in Figures 19 and 20. A listing of values also taken from the computer printout is given in Table 12. These were obtained from PSHAFT time-domain analysis of the signals; that is, the peak-to-peak fluctuations were determined and stored in the computer, and the one-third largest were then averaged. Significant double amplitudes were also listed on the Interdata printouts from Phase II. The latter are approximate, since they were obtained by multiplying the standard deviation by 4.0, a constant obtained by making the assumption that double amplitudes follow a Rayleigh distribution.

The purpose of providing significant values is to give the reader an indication of the larger responses that occur when this vehicle operates in a seaway. These are the motions, accelerations, etc. that personnel on board will be likely to feel, and which could prevent them from carrying out assigned tasks. The experimental conditions covered in the figures and tables of significant values are identical to those in the earlier presentations of standard deviation.* Since, as noted, significant and standard deviation responses differ by essentially a constant multiplier (namely, 4.0) the trends as speed, heading, etc. are varied are the same for both statistical indicators of motion severity.

The maximum significant value of cabin acceleration in a head Sea State 2 at 1.79 kts is 0.70 G's; in head Sea State 3 this increases to 0.90 G's at the same speed. These accelerations are associated mainly with pitch and heave motions since virtually no impacting occurred in the cabin region during these experiments. Significant cabin acceleration levels are much lower when the sea plane is hove-to and facing into the waves: in Sea State 2 they drop to 0.21 G's and in Sea State 3 the minimum value is 0.31 G's. Remaining on station in beam seas is not as satisfactory since the lowest cabin accelerations are then 0.37 G's, even with a reduced wave height. The best mode of operation as far as habitability is concerned, is traveling with the waves (following seas) at low speed (see Figure 20).

Figures 21 and 22 and Tables 13 through 19 contain significant model responses from Phase II as a function of heading. Here, maximum sea states

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*This is also true for Phase II results.

are more severe than for Phase I (Sea State 4 compared to Sea State 3) and the maximum value of significant cabin acceleration for zero speed is much higher, reaching 0.6 G's.

The figures indicate that pitch angles in head seas will tend to be larger than roll angles in beam seas for waves of equal severity. For example, in Figure 21 we see that the wave height employed for head sea experiments in a nominal Sea State 2 is lower than that used for beam seas. In spite of this, significant pitch reaches about 7.0 deg in head seas whereas significant roll reaches only 5.0 deg. To further support this contention, Figure 22 shows that a 33 percent reduction in wave height from head to beam seas results in beam sea roll being more than 50 percent smaller than head sea pitch. A key factor here could be the shortness of the hull beam in relation to the predominant wave length, which keeps roll excitation moments small relative to pitch moments.

RESPONSES IN COMBINED SEA AND SWELL

When experiments were conducted in combined sea and swell, the random waves approached the model from ahead and the single frequency swell approached from abeam. Two wave lengths were employed to simulate swell: based on the roll transfer function, waves 30.0 ft (9.1 m) long were used to produce maximum roll response and waves 12.6 ft (3.8 m) long were used to produce intermediate roll motion. Wave height for the swell was always about 4 in. (10.2 cm). The simultaneously generated random waves represented Sea States 2, 3 and 4.

Table 20 contains significant values of motions, rates and accelerations for the seaplane model in confused seas. The wave heights shown were measured at a single point, and represent the total contribution of the sea and swell. The seaplane responses are not much different from those occurring in unidirectional head seas, however, it should be noted that in the confused seaway pitch and roll motions will be going on concurrently. This should reduce crew comfort. Here again, the damping plates do not have a substantial effect on motions.

DRAG IN WAVES

Drag for the seaplane model when hove-to and underway at low speeds is shown in Figure 23. When the vehicle is moving forward at a speed greater than about 0.5 kts drag is greater in head seas than in following seas. Having the seaplane travel at low speed could be useful in following seas since this will help reduce motions.

CONCLUSIONS

A preliminary design of a seaplane which would be stationed hullborne for long periods of time in a "sea loiter" role has undergone seakeeping experiments. The objective of the experiments was to develop a data base for determining habitability characteristics and validating simulations. To accomplish this, motions, rates and accelerations were measured at various headings to regular and random waves for the hove-to and low speed conditions.

The following conclusions can be drawn from the results of this program:

1. The transfer functions for this vehicle are unusual, with rapid changes in response as a function of frequency often resulting in pronounced minima between peaks. This is possibly due to the wing tip floats and wings being immersed for some wave lengths and not for others.

2. The pitch, heave and roll transfer functions do not peak at frequencies close to the "natural frequencies" obtained from free oscillation tests. In fact, responses at the supposed resonance frequencies are usually small. This may also be at least partially attributed to the wings contacting the water during runs made in waves, but not during the low amplitude oscillation tests in calm water.

3. Because multiple peaks are common in the transfer functions, a close spacing of data points along the frequency scale is needed to define them accurately.

4. The effect of craft weight on responses is small within the range investigated.

5. Damping plates attached below the wing tips usually did not affect the seaplane's motions significantly.

6. For a given wave height the craft is more apt to get swamped in beam seas than at other headings. In addition, when hove-to, accelerations are more severe in beam seas than in head seas.

7. Heave does not vary much as heading ranges through values between head and following seas. Pitch and pitch rate remain relatively small in the heading range from roughly 60 deg to 120 deg. Roll can be as severe in bow and quartering seas as in beam seas.

8. The maximum standard deviation σ of cabin acceleration in head Sea State 2 is 0.18 G's at 1.8 kts. In head Sea State 3 this increases to 0.24 G's. These levels are fairly severe. The best way to loiter is underway at low speed in following seas where the σ value of the cabin acceleration can be reduced to only 0.04 G's in Sea State 3.

9. The significant (average of the highest one-third) double amplitude of cabin acceleration when underway in head Sea State 2 reaches 0.70 G's; in Sea State 3 this increase to 0.90 G's. When hove-to, these decrease to 0.21 G's in Sea State 2 and 0.31 G's in Sea State 3. In Sea State 4, the hove-to value increase to 0.6 G's.

ACKNOWLEDGMENTS

The authors wish to thank Mr. R. Stanko for his participation in assembling and operating all of the electronic instrumentation. Thanks are also due Mr. M. Davis who carried out the computer data reduction.

APPENDIX

WAVE SURFACE FOLLOWING CHARACTERISTICS OF BUOY MODEL

As discussed in Reference 2, an alternative to the use of either optimized conventional hulls or auxiliary motion alleviation devices to permit sea loitering, is the surface following configuration. This concept involves strong coupling between hull motions and wave motions. The buoy shown in Figure A1 was designed in an attempt at achieving surface following characteristics. Styrofoam and fiberglass were the principal materials used in its fabrication. Table A1 lists its principal particulars. Two ballast conditions were investigated: one for which all movable ballast was attached to a platform at the center of the buoy, and a second for which the ballast was placed in holes located at the periphery of the buoy.

THe buoy was instrumented with rate gyros and accelerometers and attached to the same towing gear used for the seaplane model during Phase I. Pitch and heave were measured with potentiometers mounted on the gimbal and heave staff.

Figure A2 presents transfer functions obtained from experiments in regular waves. In Figure A2a it can be seen that pitch response is small at frequencies above about 3.5 rad/sec. For lower frequencies (closer to the natural pitch frequency) the motion increases quickly and large magnification factors approaching 2.4 are reached. It should be noted

that if the scale ratio of this buoy were 7.5*, the prototype's natural pitch period would be 6.6 sec. Waves having periods close to this are prevalent in Sea State 3, and the buoy would probably pitch severely in this sea state.

Magnification for heave at low frequencies is much lower than that for pitch (see Figure A2b). Even at the natural heave frequency of 5.7 rad/sec heave per unit wave amplitude is only about 0.3; this is indicative of heavy damping in heave. At lower frequencies (longer waves) the heave transfer function increases, and approaches 1.0. It is here that surface following is taking place in the heave mode.

The heave acceleration and pitch rate transfer functions given in Figures A2c and A2d, respectively[+] both have two major peaks: one occurs at low frequencies where heave and pitch displacements are relatively large; the other occurs at high frequency since accelerations and rates result from the multiplication of displacement and a power of frequency.

The location of the ballast--whether it be at the center or at the outside--had only a small effect on the heave and pitch displacements; however, the high and low frequency peaks of the heave acceleration response curves, and the high frequency pitch rate response appear to be significantly affected by ballast condition. This is true even though the natural periods were not measurably altered by movement of the ballast (see Table A1). The reason for this is not clear at the present time.

A summary of buoy responses in random waves respresenting Sea States 2, 3, and 4 is presented in Table A2. Here again, the effect of ballast location on motions is small. Heave acceleration levels of approximately 0.05 G's in Sea State 4 are low enough to be tolerated for a long period of time.

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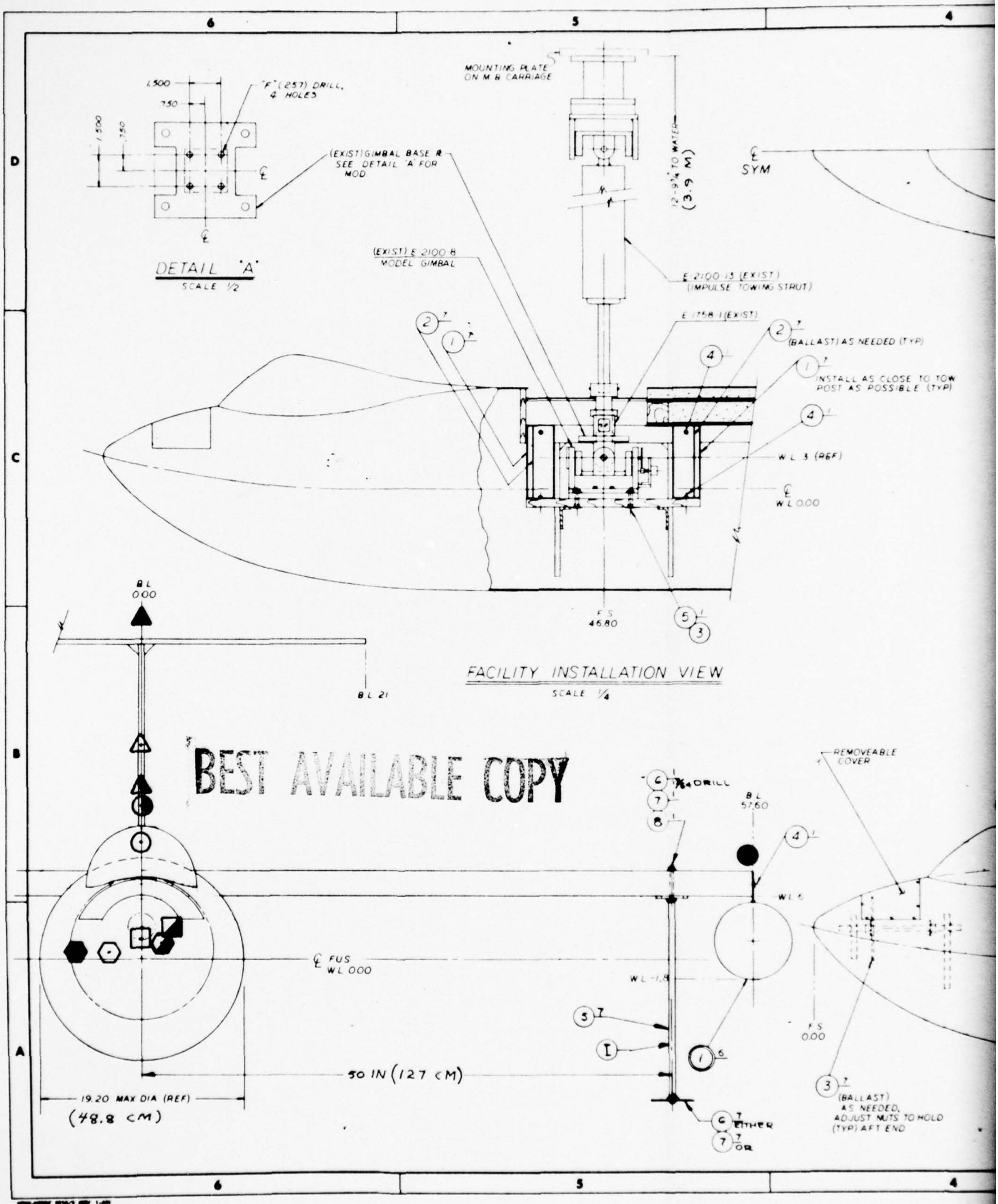
*This is the value used for scaling sea states.
+The value of L used in the ordinate is 96.0 in.

REFERENCES

1. Meeks, T L., Capt and Mantle, P., "The Advanced Naval Vehicle Concept Evaluation", AIAA/SNAME Advanced Marine Vehicles Conference Arlington, Va., Paper No. 76-846 (Sep 1976)

2. Papadales, B.S., Jr., "A Review of Sea Loiter Aircraft Technology", AIAA/SNAME Advanced Marine Vehicles Conference, Arlington, Va., Paper No. 76-876 (Sep 1976)



MOUNTING PLATE ON M.B CARRIAGE
"F" (.257) DRILL, 4 HOLES
(EXIST) GIMBAL BASE PL SEE DETAIL "A" FOR MOD
12'-9 3/4" TO WATER (3.9 M)
SYM
DETAIL "A"
SCALE 1/2
(EXIST) E-2100-8 MODEL GIMBAL
E-2100-13 (EXIST) (IMPULSE TOWING STRUT)
E-1758-1 (EXIST)
(BALLAST) AS NEEDED (TYP)
INSTALL AS CLOSE TO TOW POST AS POSSIBLE (TYP)
W.L. 3 (REF)
W.L. 0.00
F.S. 46.80
BL 0.00
BL 21
FACILITY INSTALLATION VIEW
SCALE 1/4
BEST AVAILABLE COPY
REMOVEABLE COVER
DRILL
BL 57.60
WL 6
FUS WL 0.00
WL -1.8
F.S. 0.00
50 IN (127 CM)
19.20 MAX DIA (REF)
(48.8 CM)
EITHER
OR
(BALLAST) AS NEEDED, ADJUST NUTS TO HOLD (TYP) AFT END

Figure 1 -

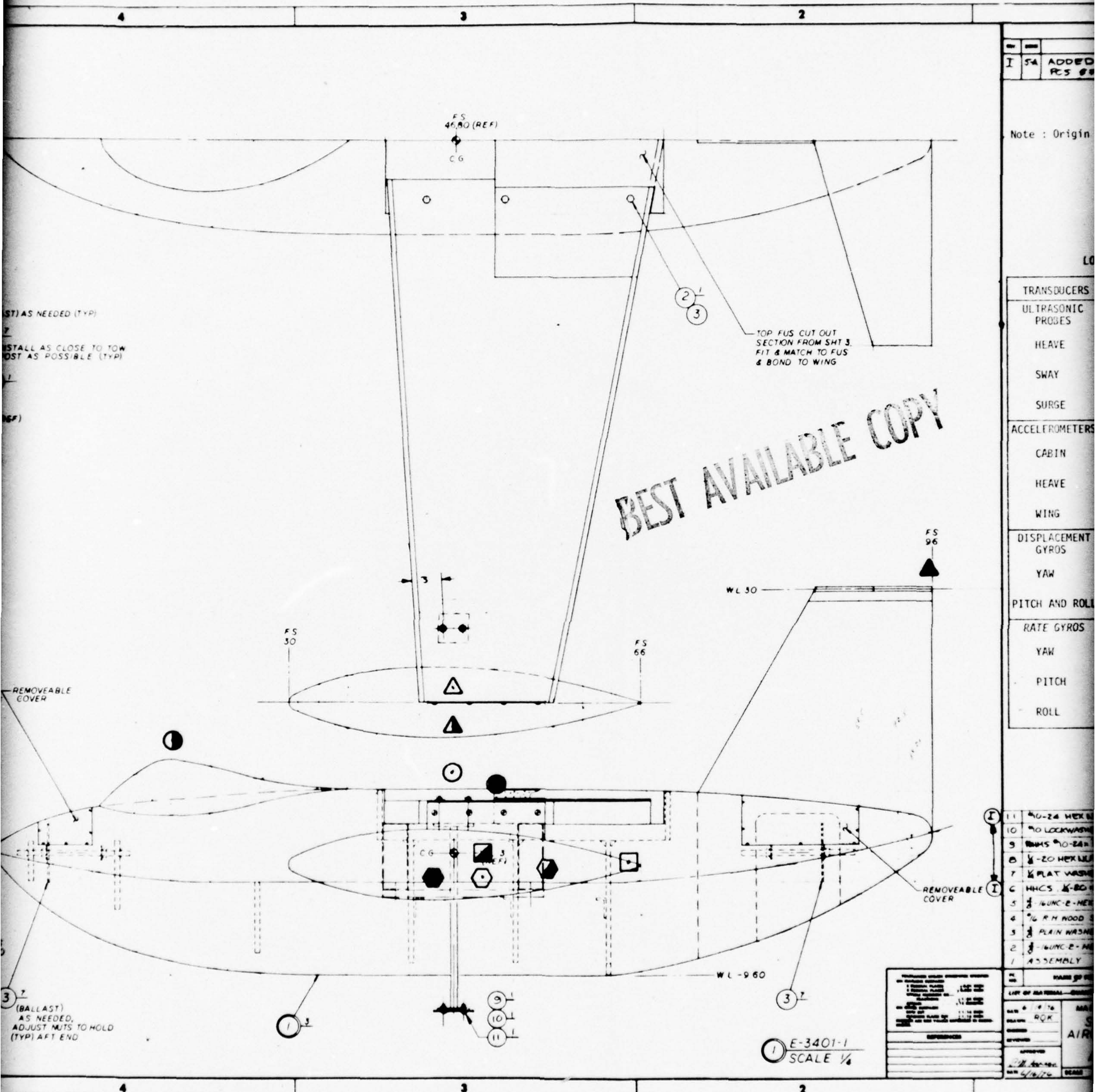
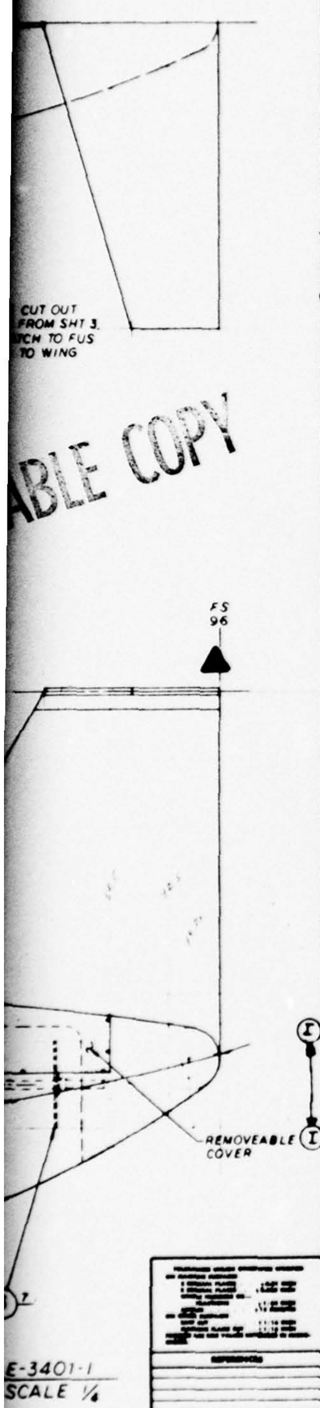


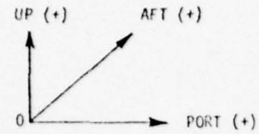
Figure 1 - Drawing of Sea Loiter Aircraft Model



REVISIONS

		DESCRIPTION			
I	5A	ADDED PCS 5-7, 6-7, & 8-7. ADDED PCS 6 THRU 11 IN B/M			

Note : Origin taken at 0.0 FS, 0.0 BL and 0.0 WL.



LOCATION OF TRANSDUCERS

TRANSDUCERS	SYMBOL	FS	BL	WL
ULTRASONIC PROBES				
HEAVE	△	46.8 IN 118.9 CM	0.0 IN 0.0 CM	20.0 IN 50.8 CM
SWAY	half-filled triangle	46.8 IN 118.9 CM	0.0 IN 0.0 CM	16.0 IN 40.6 CM
SURGE	▲	95.8 IN 243.3 CM	0.0 IN 0.0 CM	32.0 IN 81.3 CM
ACCELEROMETERS				
CABIN	◐	17.8 IN 45.2 CM	0.0 IN 0.0 CM	14.5 IN 36.8 CM
HEAVE	○	46.8 IN 118.9 CM	0.0 IN 0.0 CM	11.0 IN 27.9 CM
WING	●	51.3 IN 130.3 CM	57.0 IN 144.8 CM	10.0 IN 25.4 CM
DISPLACEMENT GYROS				
YAW	◪	49.8 IN 126.5 CM	3.0 IN 7.6 CM	3.0 IN 7.6 CM
PITCH AND ROLL	□	64.8 IN 164.6 CM	0.0 IN 0.0 CM	2.0 IN 5.1 CM
RATE GYROS				
YAW	half-filled hexagon	56.3 IN 143.0 CM	2.0 IN 5.1 CM	1.5 IN 3.8 CM
PITCH	⬡	49.8 IN 126.5 CM	-3.0 IN -7.6 CM	0.5 IN 1.3 CM
ROLL	⬢	44.8 IN 113.8 CM	-6.0 IN -15.2 CM	0.5 IN 1.3 CM

PC NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	STD. NAVY STOCK NO.	
11	#10-24 HEX NUT	4	STEEL		
10	#10 LOCKWASHER	4	STEEL		
9	RHMS #10-24 × 3/4	4	STEEL		
8	1/4-20 HEX NUT	4	STEEL		
7	1/4 FLAT WASHER	4	STEEL		
6	HHCS 1/4-20 × 3	4	STEEL		
5	3/8-16UNC-2-HEX BOLT	4	STEEL - 1 1/2 LG		
4	#16 R H WOOD SCREW	16	BRASS - 1 1/2 LG		
3	3/8 PLAIN WASHER	10	STEEL		
2	3/8-16UNC-2-HEX BOLT	6	STEEL - 4 1/2 LG		
1	ASSEMBLY	1			

LIST OF MATERIAL—QUANTITIES FOR ONE

REFERENCES

DATE 6/14/76
DRAWN RQK
APPROVED
DATE 6/16/76

MANEUVERING BASIN
SEA LOITER
AIRCRAFT MODEL
1/5 SCALE
ASSEMBLY

SCALE 1/4

DEPARTMENT OF THE NAVY
NAVAL SHIP
RESEARCH & DEVELOPMENT
CENTER
WASHINGTON, D.C.

E 16-3401-1 I

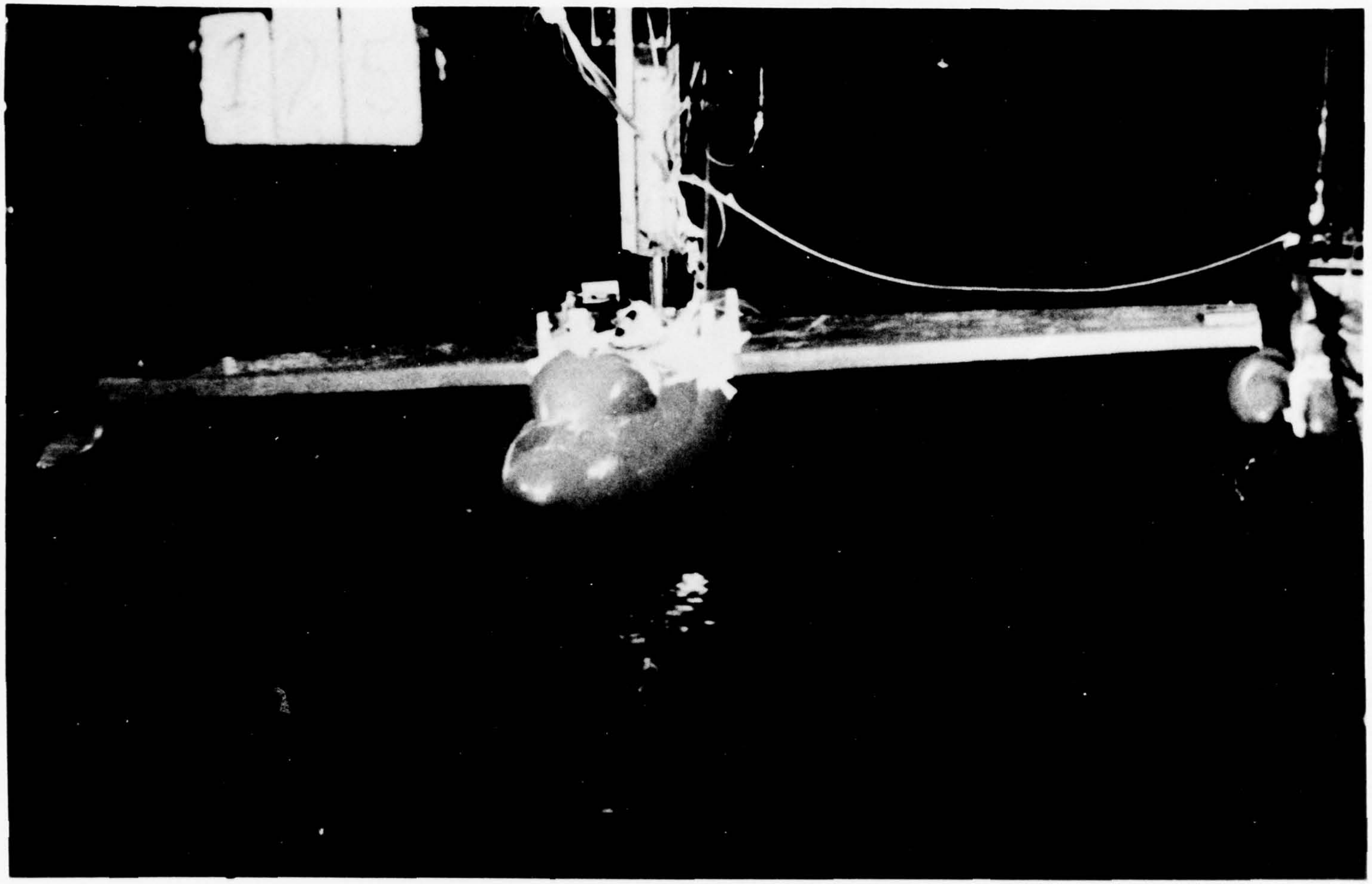


Figure 2 - Setup for Phase 1 Towing Tank Experiments

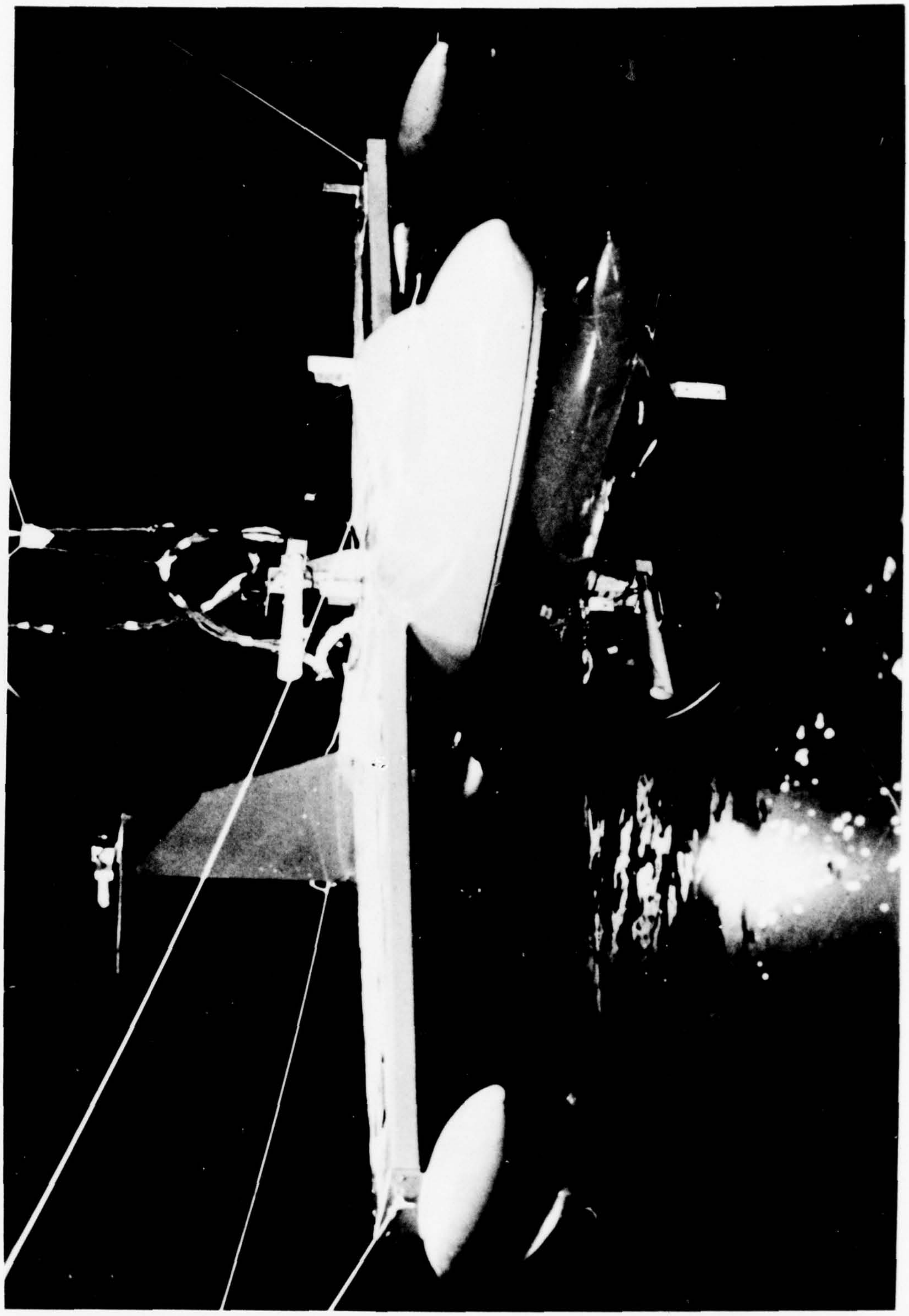


Figure 3 - Setup for Phase 2 Towing Tank Experiments

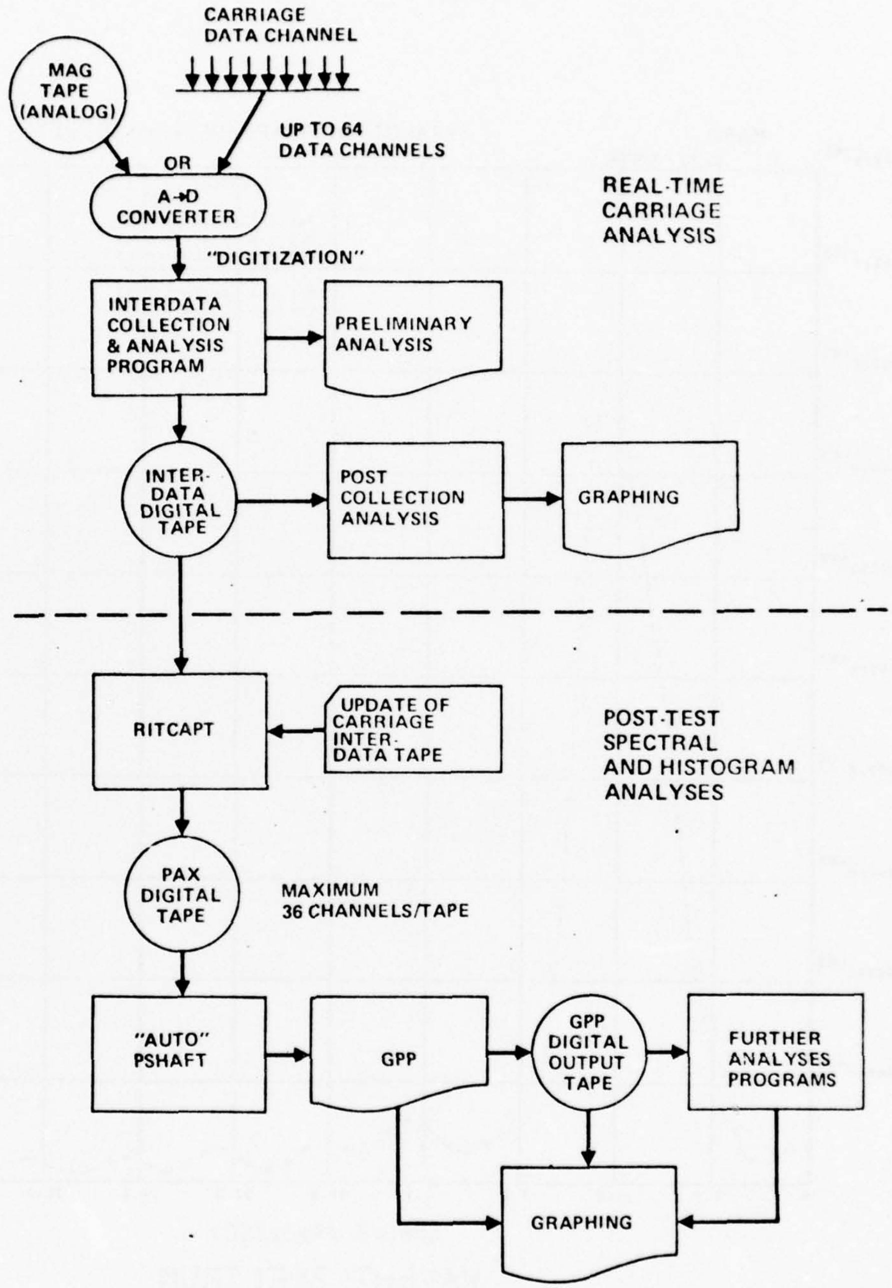


Figure 4 - Flow Chart for Computer Analysis

Figure 5 - Samples of Wave Spectra Obtained from Measurements Made During Experiments

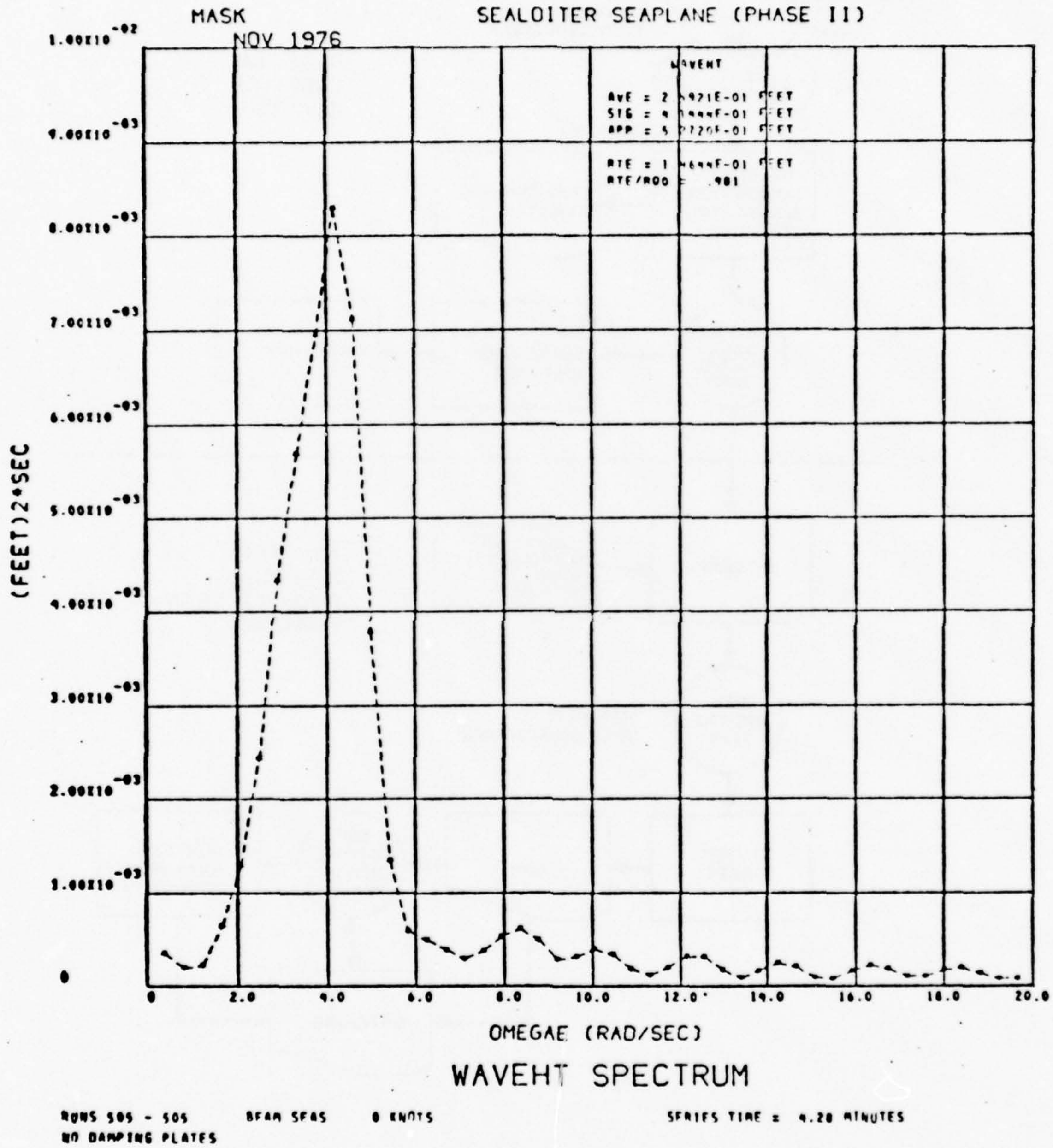


Figure 5a - Sea State 2

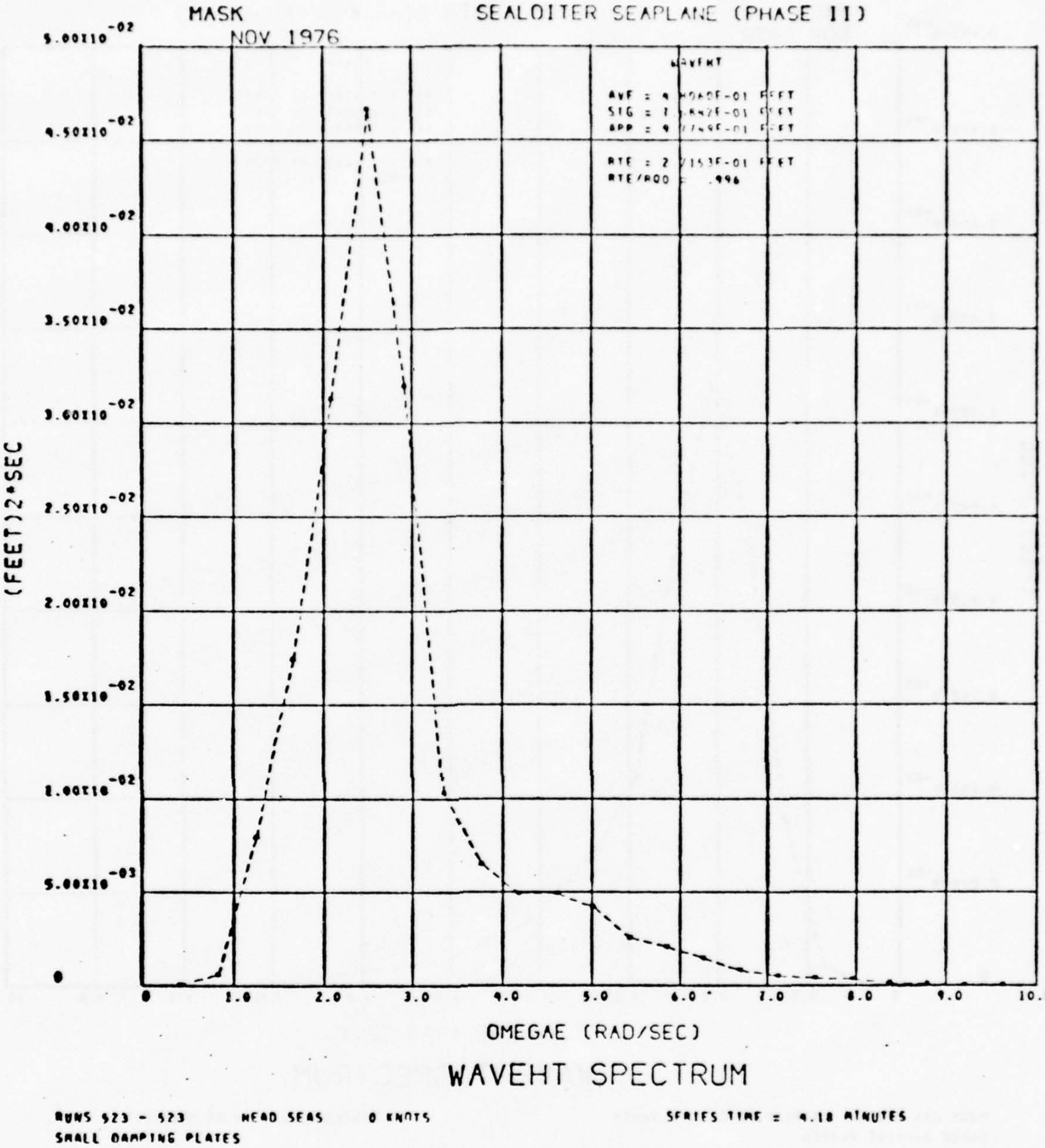


Figure 5b - Sea State 3

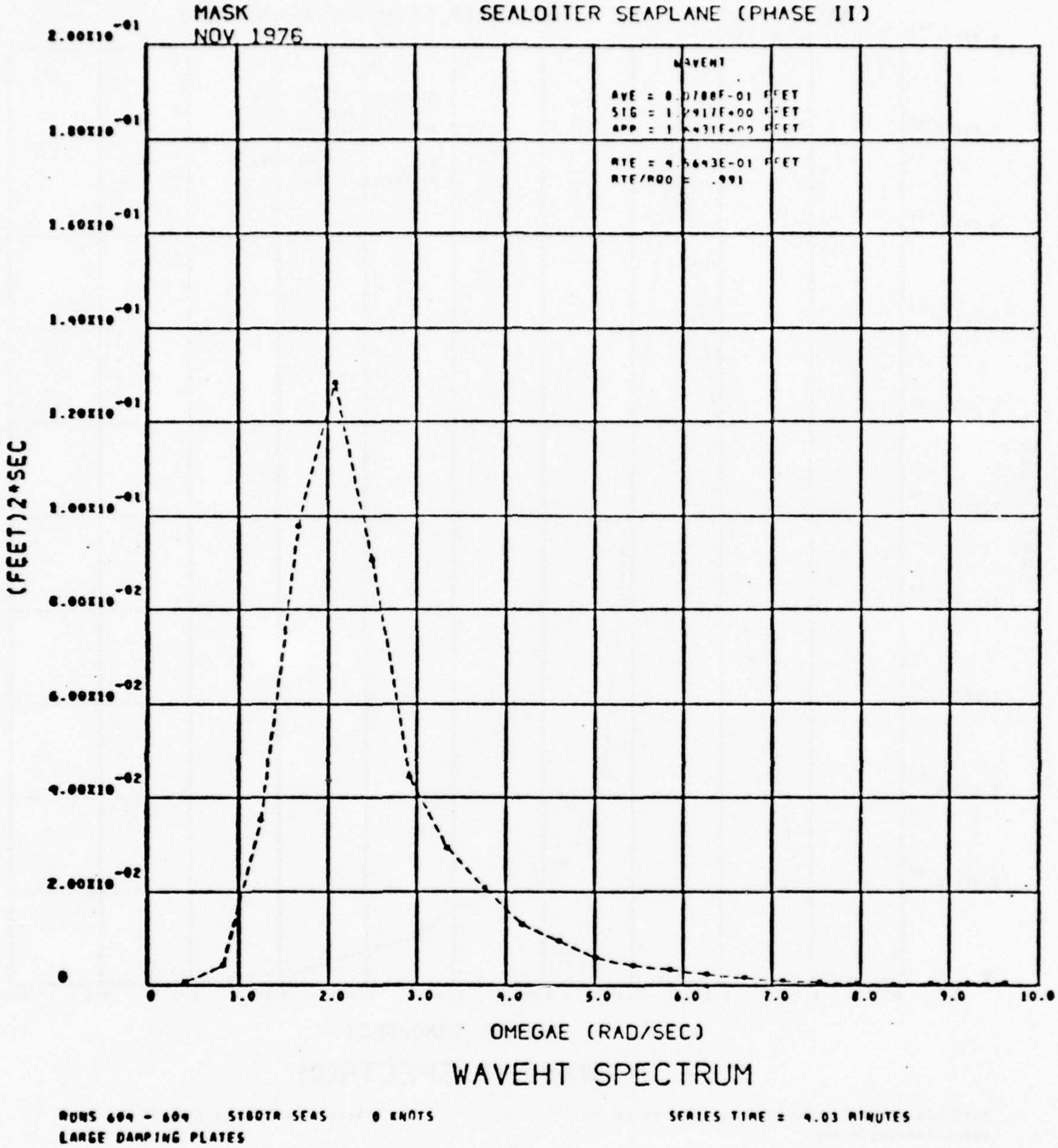


Figure 5c - Sea State 4

Figure 6 - Sample Computer Printout from Real-Time Analysis of Regular Wave Run

```
MASK                          SEA LOITER :  SEAPLANE (PHASE II)                10 NOV  1976

                                       REGULAR WAVES

       FE =     0.955 HZ                WE =     5.999 RAD/SEC            TE =     1.047 SEC

       F0 =     0.955 HZ                W0 =     5.999 RAD/SEC            T0 =     1.047 SEC

   LAMBDA =     5.617 FT        WAVE SLOPE =     6.510 DEG          CELERITY =     3.178 KTS
 LAMBDA/L =     0.762           WAVE STPN  =     0.036              LAMBDA/H =    27.649

                                   HEADING = 180.0  DEG

                                NOMN SPEED =    0.00 KNOTS

RUN NO  568                                                           TIME:       0.000 -  16.758
                                                                      RECORDS:      1   -    25
```

	CHAN		CALIB	GAIN	MEAN	STDDEV	ROOTG0
1	WAVE HT	IN	8.333E 00	5.000E 00	-1.469E-02	8.620E-01	1.219E 00
2	HEAVE	IN	1.000E 01	5.000E 00	-2.941E-02	8.094E-02	1.145E-01
3	SWAY	IN	2.400E 01	2.000E 00	8.497E 00	1.577E 00	2.231E 00
4	SURGE	IN	2.400E 01	2.000E 00	-3.044E 00	2.263E 00	3.200E 00
5	PITCH	DEG	1.000E 00	2.500E-01	9.682E-02	5.669E-01	0.017E-01
6	ROLL	DEG	1.667E 00	2.500E-01	-3.124E-01	8.032E-01	1.136E 00
7	YAW	DEG	1.000E 00	2.500E-01	-1.266E 00	6.706E-01	9.434E-01
8	HEAVEACC	G	1.000E 00	4.000E 00	-2.295E-04	7.325E-03	1.036E-02
9	CABINACC	G	4.000E 00	4.000E 00	-5.227E-04	2.111E-02	2.986E-02
10	WING ACC	G	4.000E 00	4.000E 00	-3.374E-03	4.322E-02	6.112E-02
11	PITCH RT	DPS	1.500E 00	2.500E-01	2.378E-02	2.891E 00	4.089E 00
12	ROLL RT	DPS	1.500E 00	2.500E-01	-2.973E-01	2.163E 00	3.060E 00
13	YAW RT	DPS	2.000E-01	5.000E-02	4.088E-02	3.005E-01	4.249E-01

```
RUN    568.

NO OF CYCLES =    16  AVERAGE PERIOD =    1.0474 SEC

MAX PERIOD =    1.079 SEC
AVG PERIOD =    1.047 SEC
MIN PERIOD =    1.017 SEC

MAX DBL AMP =    1.519
AVG DBL AMP =    1.468
MIN DBL AMP =    1.402
```

Figure 6a - Minimum Analysis

MASK | SEA LOITER : SEAPLANE (PHASE II) | 10 NOV 1976

REGULAR WAVES

NCYCLS = 16

FE =	0.955 HZ	WE =	5.999 RAD/SEC	TE =	1.047 SEC
F0 =	0.955 HZ	W0 =	5.999 RAD/SEC	T0 =	1.047 SEC
LAMBDA =	5.617 FT	WAVE SLOPE =	6.510 DEG	CELERITY =	3.170 KTS
LAMBDA/L =	0.762	WAVE STPN =	0.036	LAMBDA/H =	27.649

HEADING = 180.0 DEG

NOMN SPEED = 0.00 KNOTS

RUN NO 563

TIME: 0.000 - 16.758
RECORDS: 1 - 25

FREQ MULTIPLE						1.0		2.0		3.0	
	CHAN		ROOTOO	AMP1/ROO	TRN FUN	AMP1	PHASE	AMP2	PHASE	AMP3	PHI SL
1	WAVE HT	IN	1.219E 00	9.93E-01	1.00E 00	1.210E 00	0.0	1.132E-01	-1.6	2.040E-02	-31.7
2	HEAVE	IN	1.145E-01	9.61E-01	9.05E-02	1.100E-01	42.0	1.446E-03	-91.4	8.235E-04	-200.9
3	SWAY	IN	2.231E 00	2.17E-01	4.00E-01	4.841E-01	-98.2	5.133E-02	-248.5	3.946E-02	50.3
4	SURGE	IN	3.200E 00	6.67E-02	1.76E-01	2.135E-01	-169.8	6.157E-02	15.2	4.005E-02	-31.6
5	PITCH	DEG	8.017E-01	9.90E-01	1.23E-01	7.937E-01	48.7	1.947E-02	94.1	1.498E-02	25.9
6	ROLL	DEG	1.136E 00	9.51E-01	1.67E-01	1.081E 00	2.3	2.141E-01	-230.9	2.600E-03	-85.3
7	YAW	DEG	9.484E-01	6.30E-02	9.25E-03	5.974E-02	11.7	8.609E-03	-228.1	4.512E-03	-117.6
8	HEAVEACC	G	1.036E-02	9.72E-01	8.93E-02	1.007E-02	44.4	1.029E-03	-62.8	1.102E-04	-202.4
9	CABINACC	G	2.986E-02	9.82E-01	2.60E-01	2.932E-02	-133.1	2.589E-03	-74.4	7.754E-04	-221.5
10	WING ACC	G	6.112E-02	6.82E-01	3.70E-01	4.168E-02	-193.9	4.203E-02	-50.6	3.221E-03	-202.9
11	PITCH RT	DPS	4.089E 00	9.87E-01	1.04E-01	4.036E 00	133.0	8.718E-02	-130.1	8.837E-02	-292.4
12	ROLL RT	DPS	3.060E 00	8.98E-01	7.09E-02	2.748E 00	78.1	1.086E 00	-159.4	1.892E-02	-122.9
13	YAW RT	DPS	4.249E-01	4.40E-01	4.82E-03	1.869E-01	94.8	3.679E-02	-124.3	9.293E-03	-261.6

Figure 6b - Harmonic Analysis

Figure 7 - Transfer Functions for Seaplane Model Obtained in Head Regular Waves During Phase 1

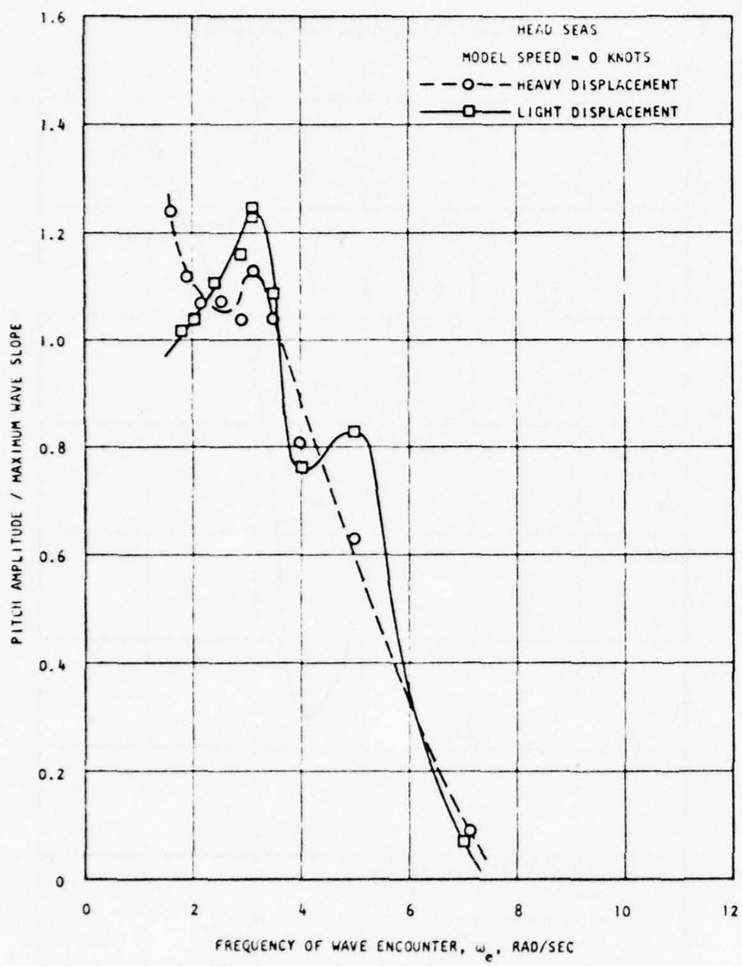


Figure 7a - Pitch Transfer Function

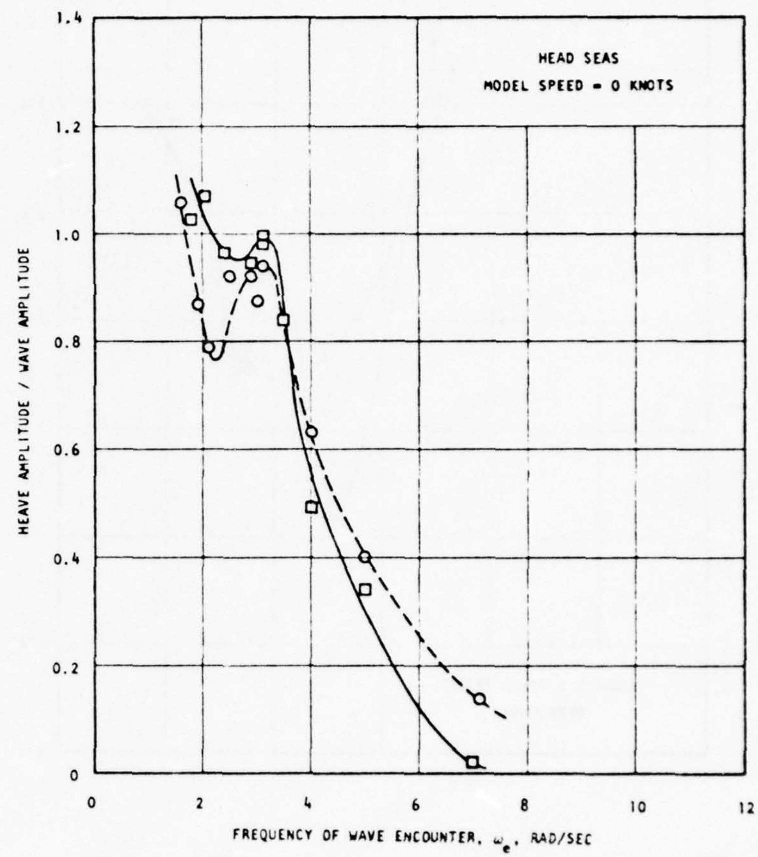


Figure 7b - Heave Transfer Function

Figure 7 - Continued

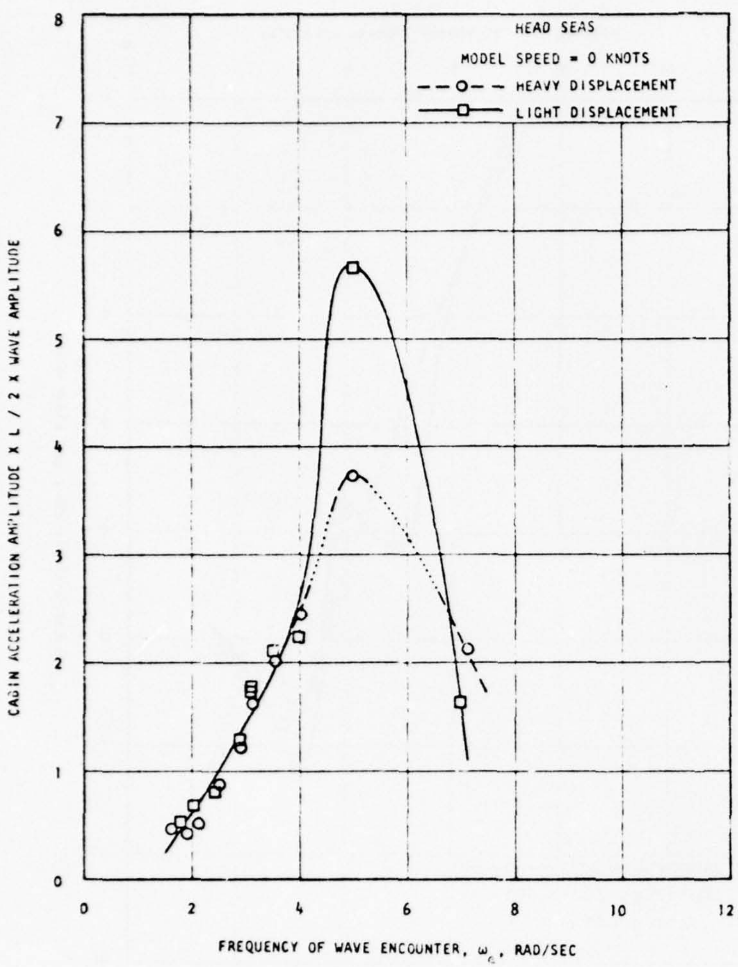


Figure 7c - Cabin Acceleration Transfer Function

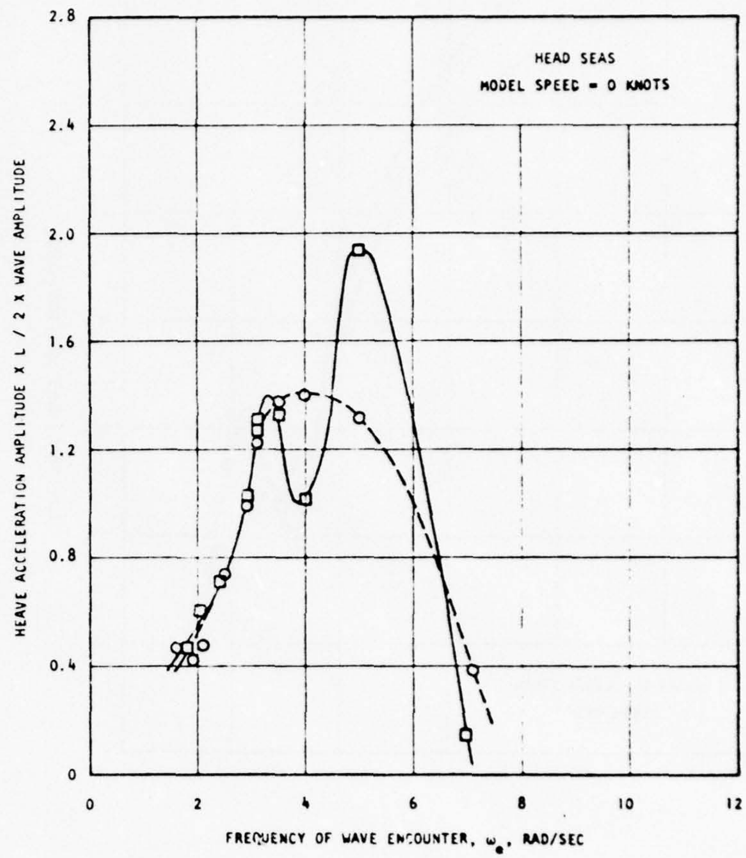


Figure 7d - Heave (CG) Acceleration Transfer Function

Figure 7 - Concluded

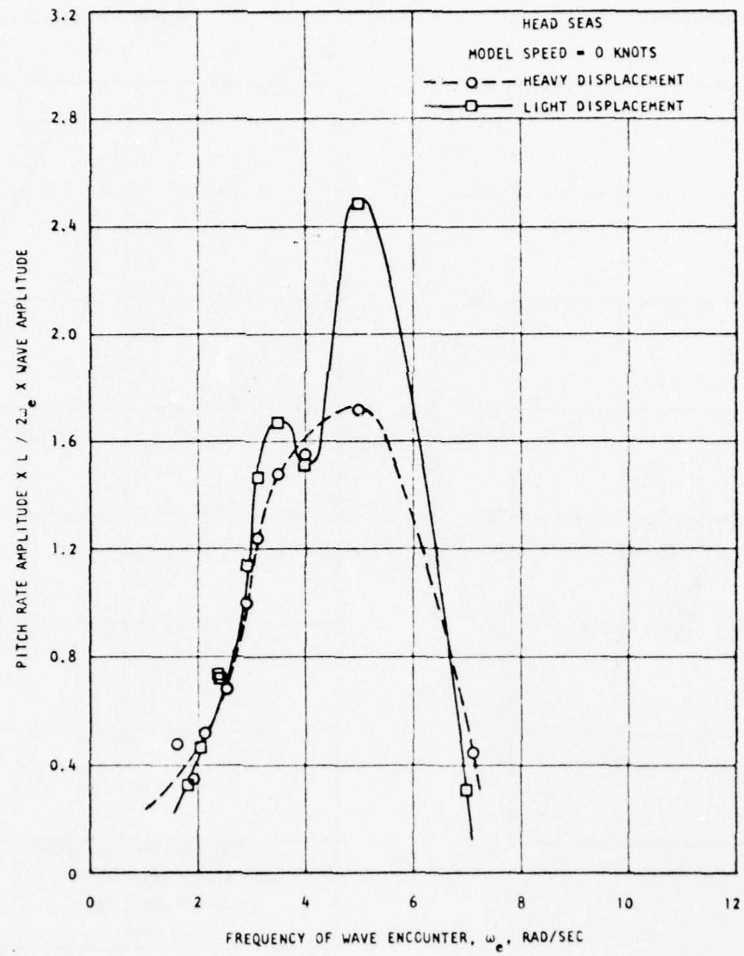


Figure 7e - Pitch Rate Transfer Function

Figure 8 - Transfer Functions for Seaplane Model Obtained in Beam Regular Waves During Phase 1

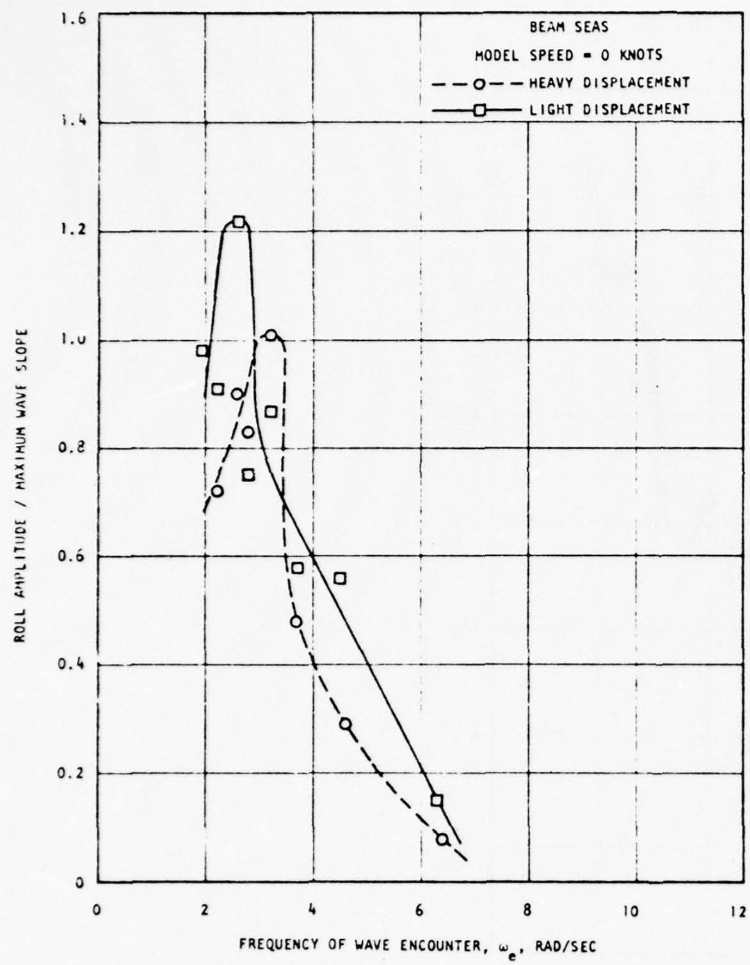


Figure 8a - Roll Transfer Function

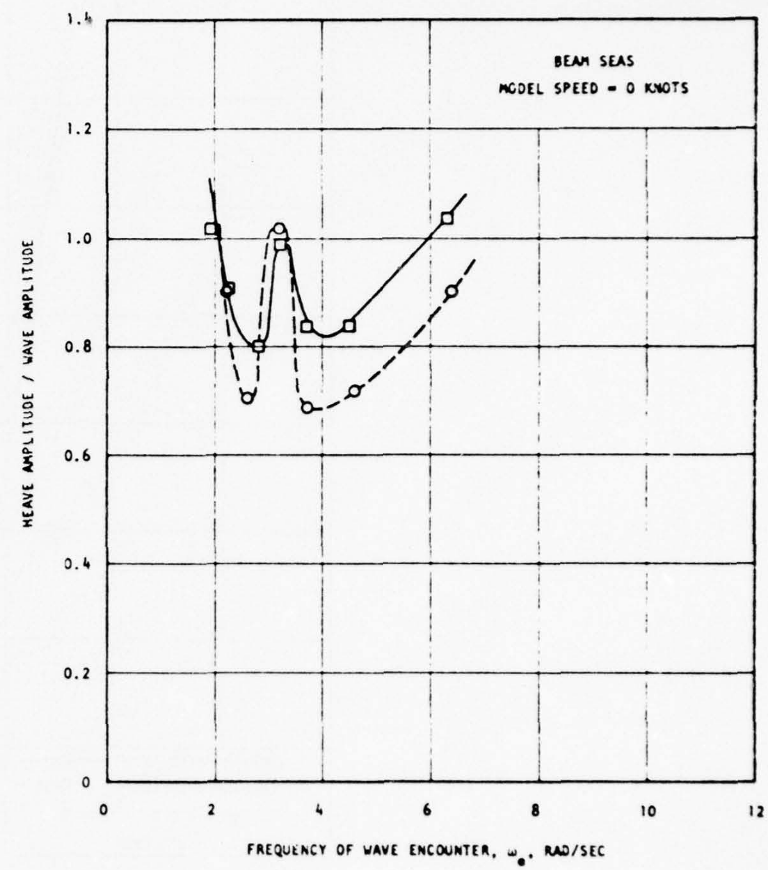


Figure 8b - Heave Transfer Function

Figure 8 - Continued

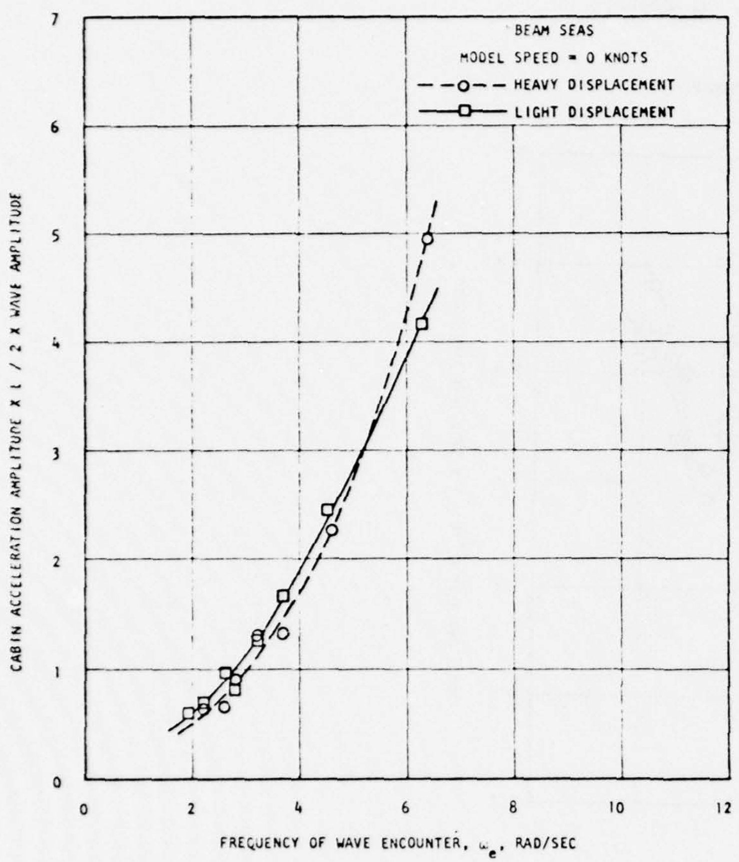


Figure 8c - Cabin Acceleration Transfer Function

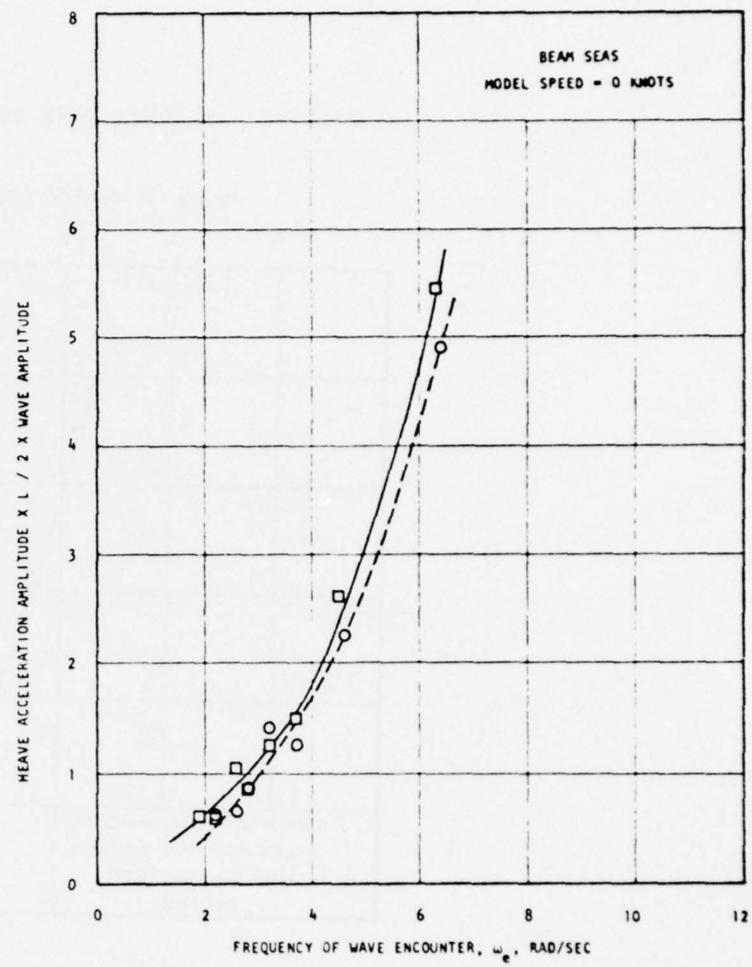


Figure 8d - Heave (CG) Acceleration Transfer Function

Figure 8 - Concluded

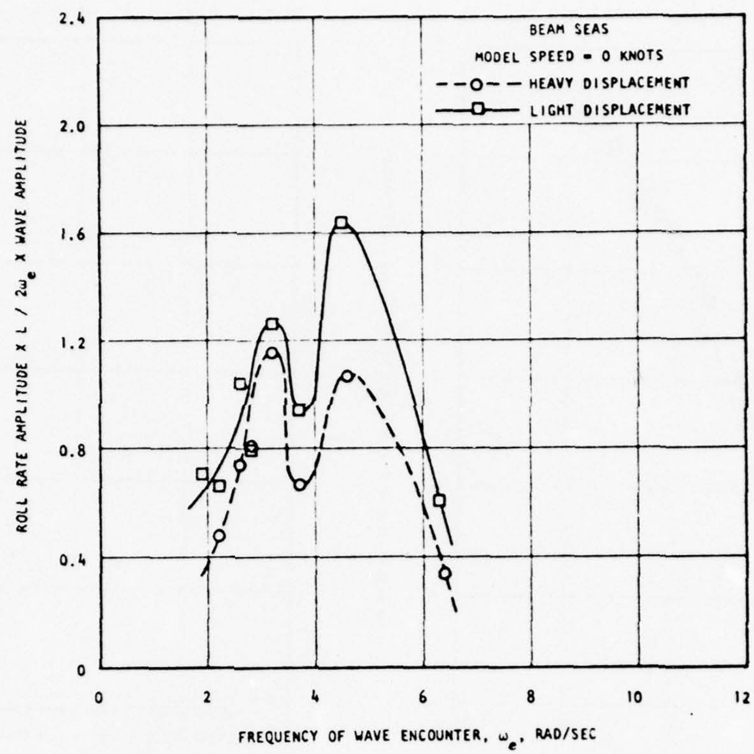


Figure 8e - Roll Rate Transfer Function

Figure 9 - Transfer Functions for Seaplane Model
Obtained in Head Regular Waves During Phase 2

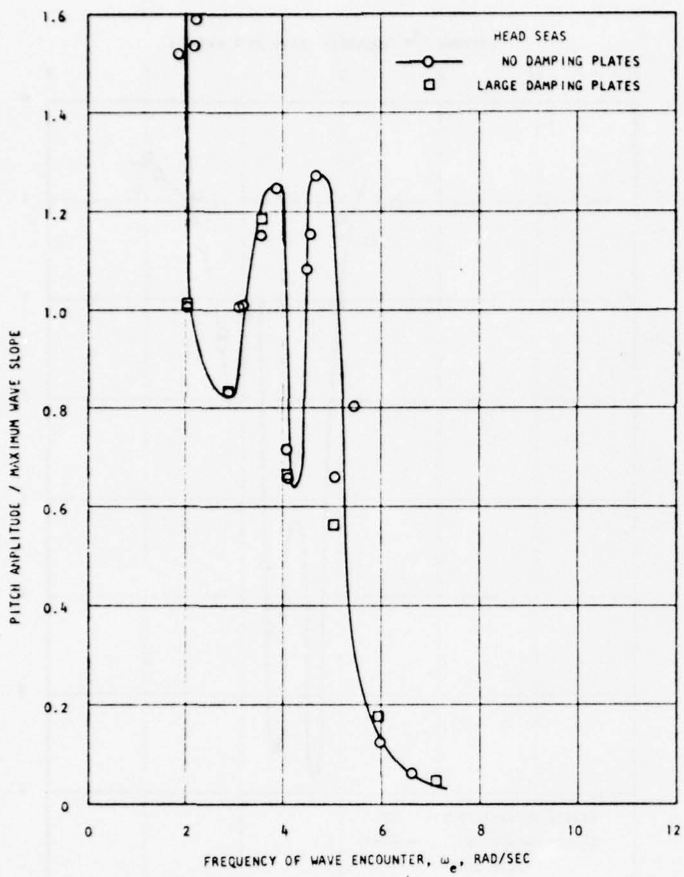


Figure 9a - Pitch Transfer Function

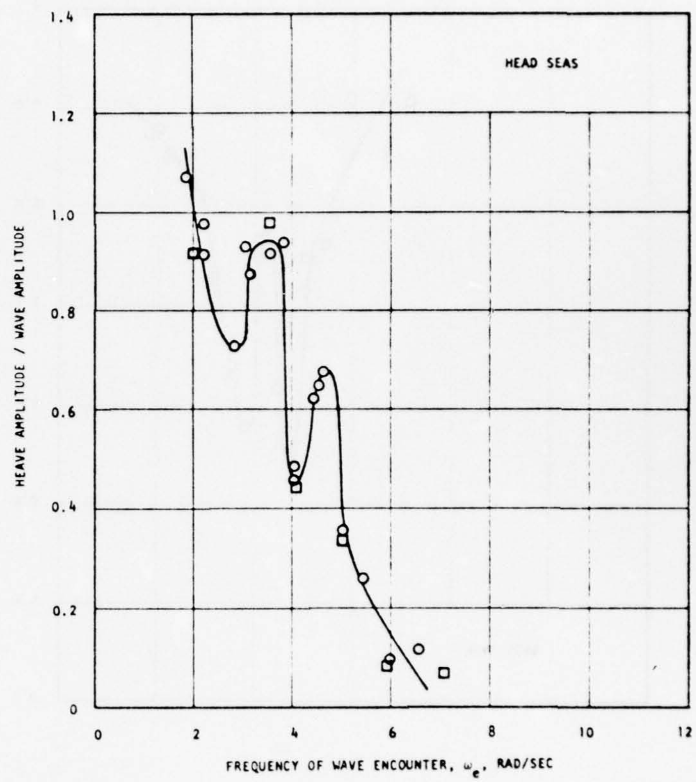


Figure 9b - Heave Transfer Function

Figure 9 - Continued

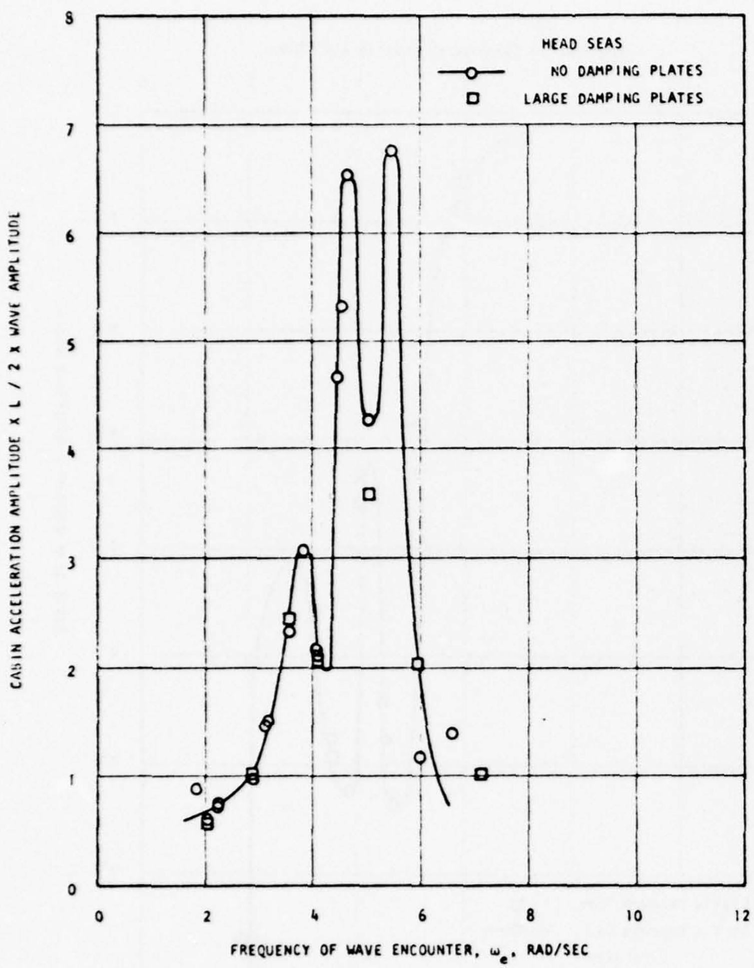


Figure 9c - Cabin Acceleration Transfer Function

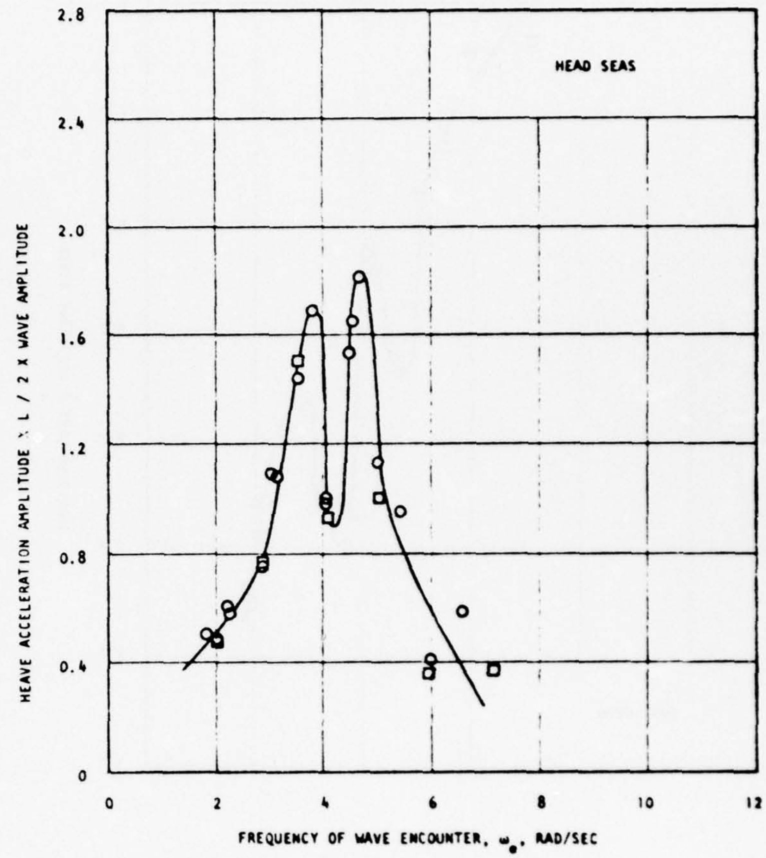


Figure 9d - Heave (CG) Acceleration Transfer Function

Figure 9 - Concluded

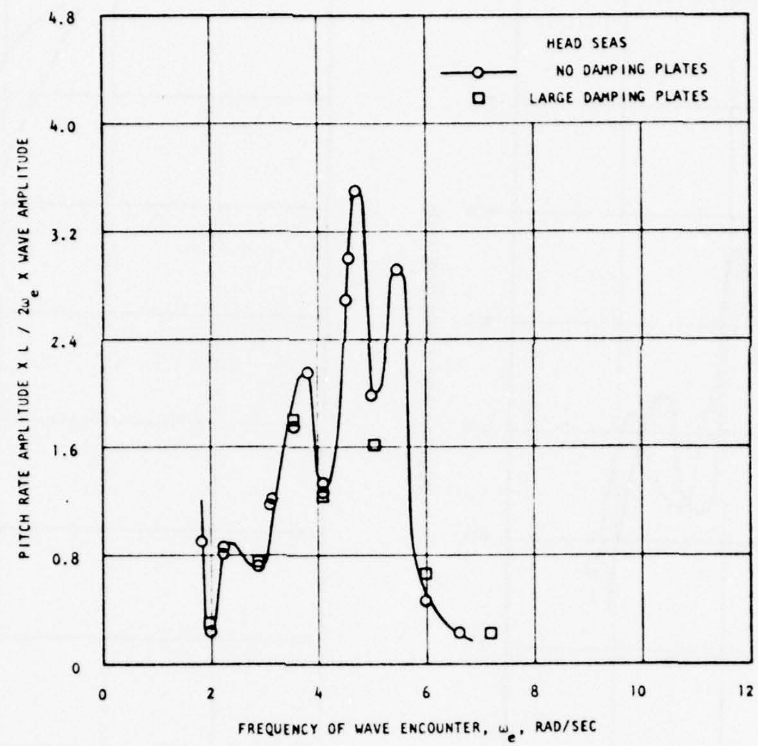


Figure 9e - Pitch Rate Transfer Function

Figure 10 - Comparison of Phase 1 and Phase 2 Head Sea Transfer Functions

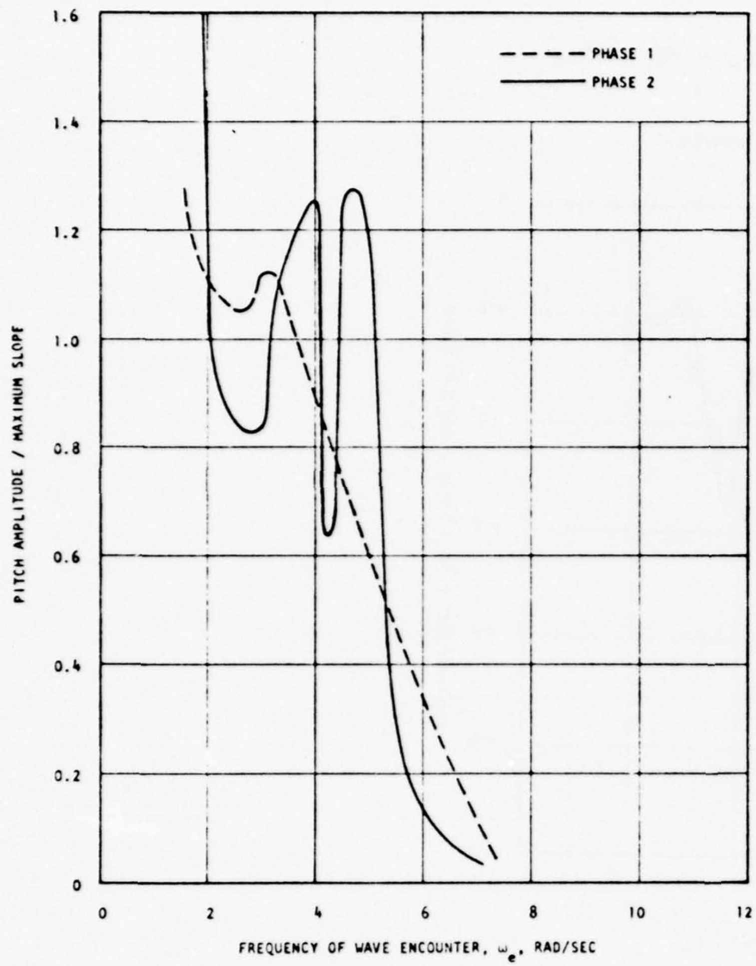


Figure 10a - Pitch Transfer Functions

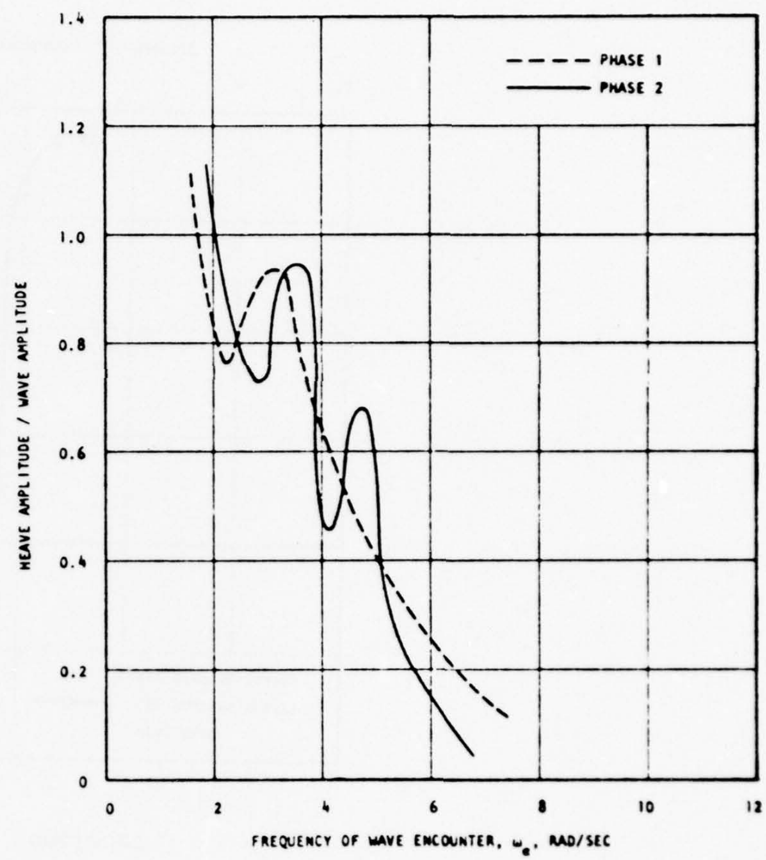


Figure 10b - Heave Transfer Functions

Figure 10 - Concluded

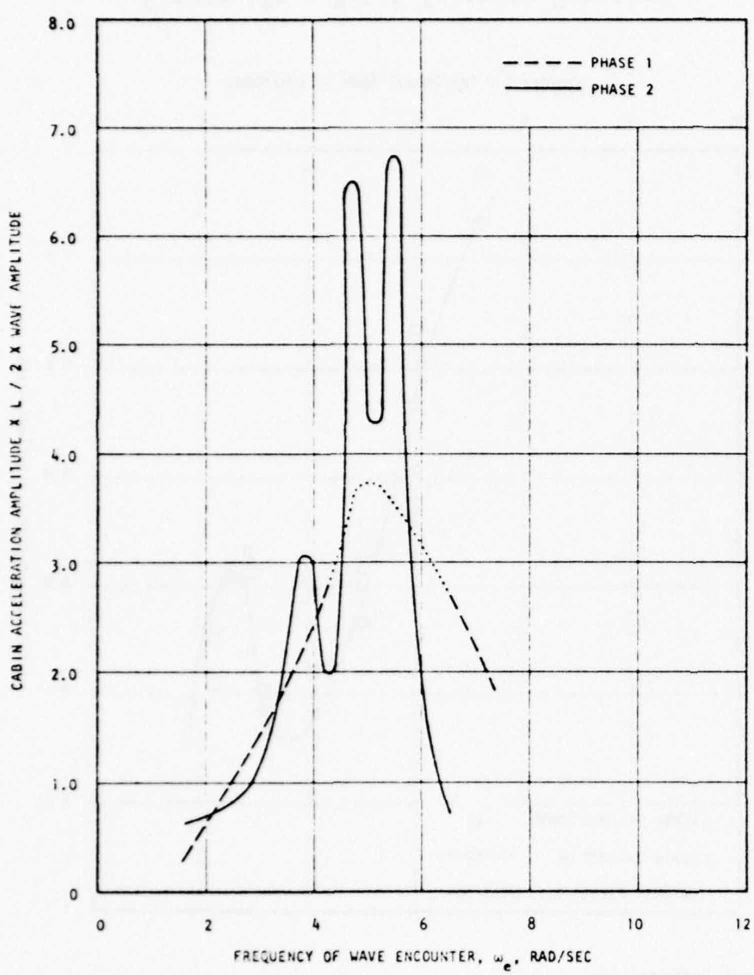


Figure 10c - Cabin Acceleration Transfer Functions

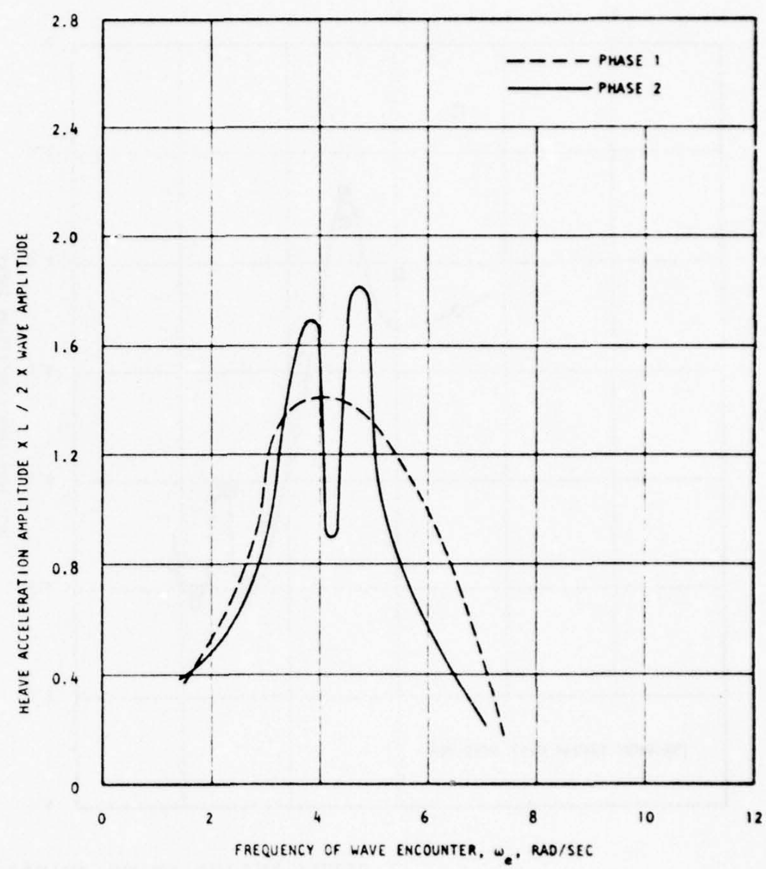


Figure 10d - Heave (CG) Acceleration Transfer Function

Figure 11 - Transfer Functions for Seaplane Model
Obtained in Bow Regular Waves During Phase 2

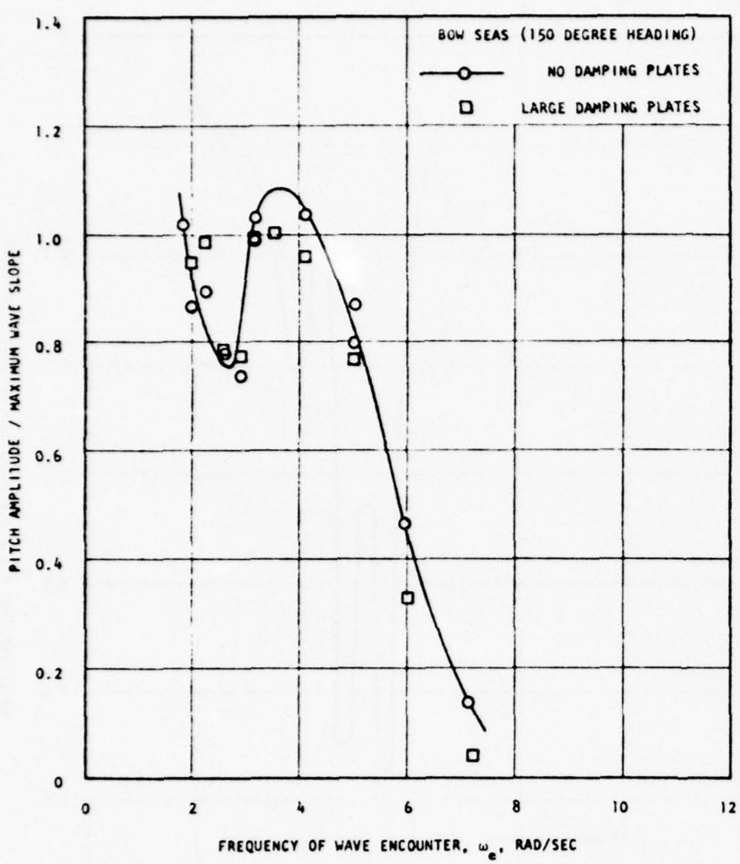


Figure 11a - Pitch Transfer Function

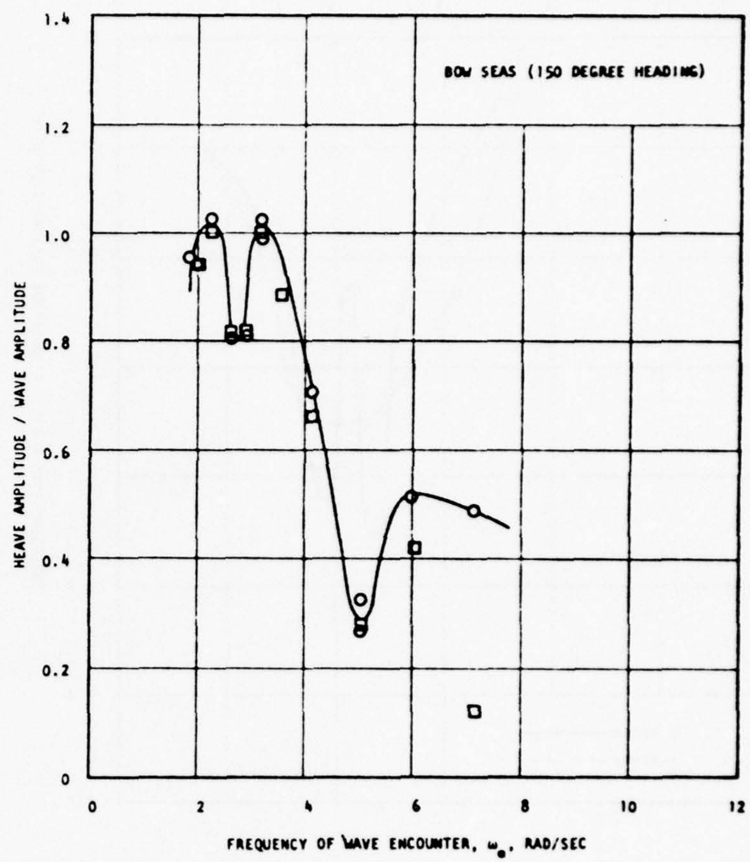


Figure 11b - Heave Transfer Function

Figure 11 - Continued

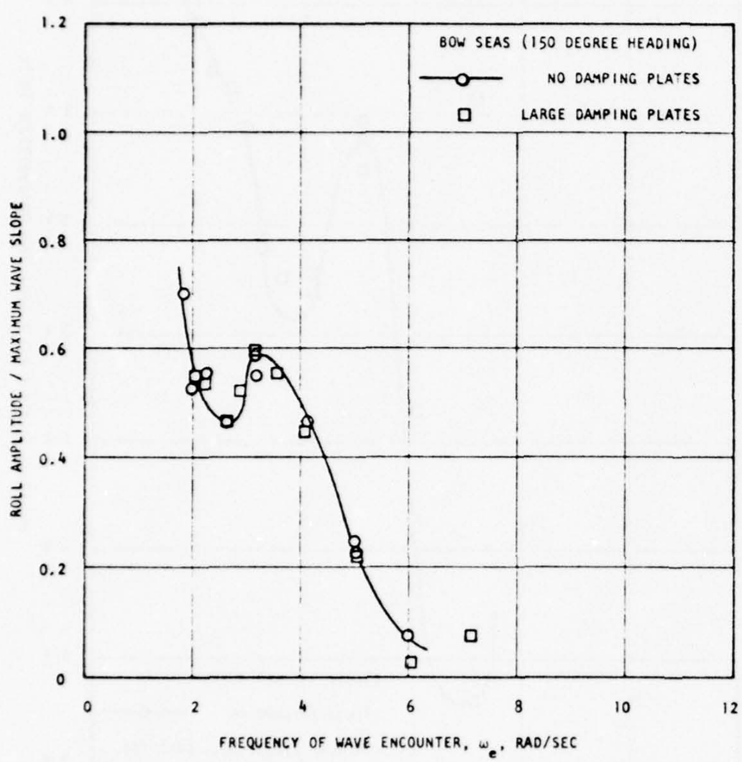


Figure 11c - Roll Transfer Function

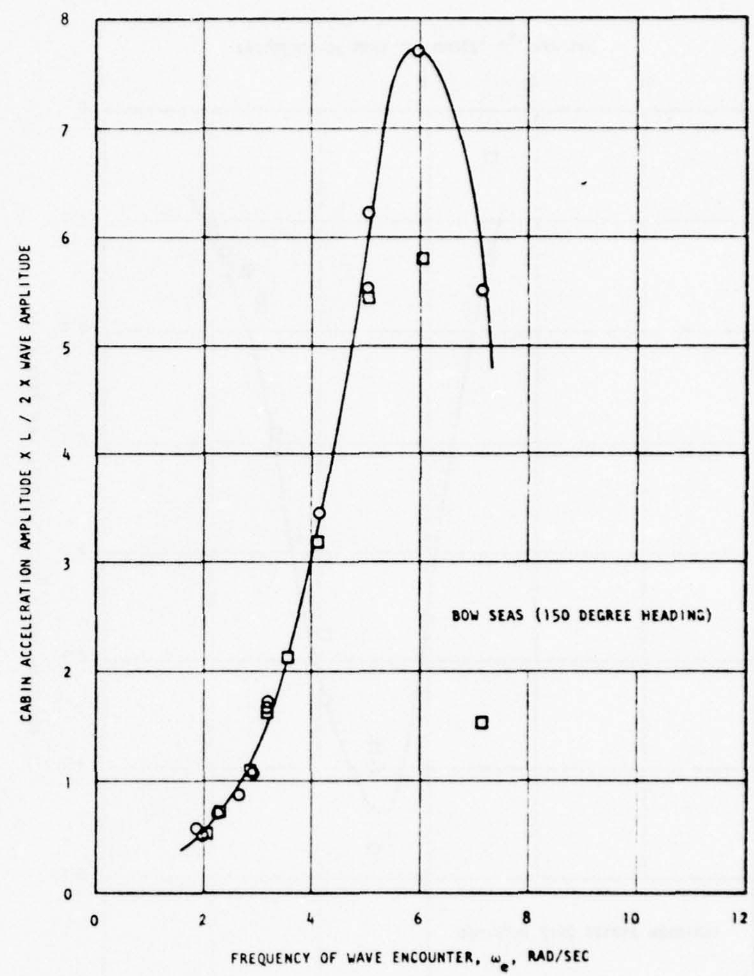


Figure 11d - Cabin Acceleration Transfer Function

Figure 11 - Continued

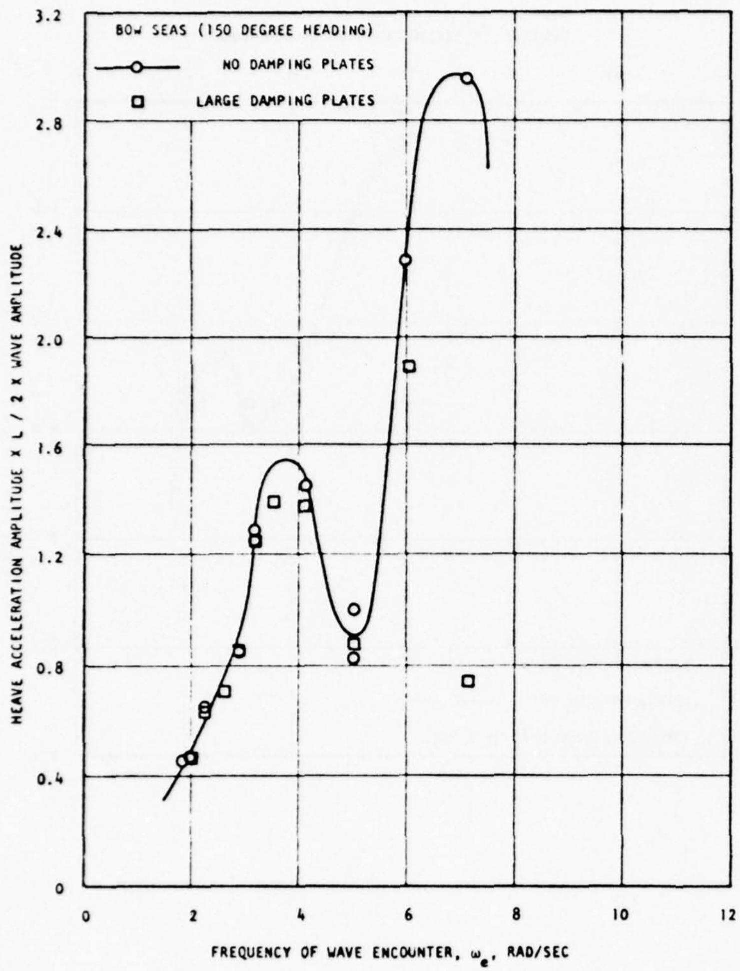


Figure 11e - Heave (CG) Acceleration Transfer Function

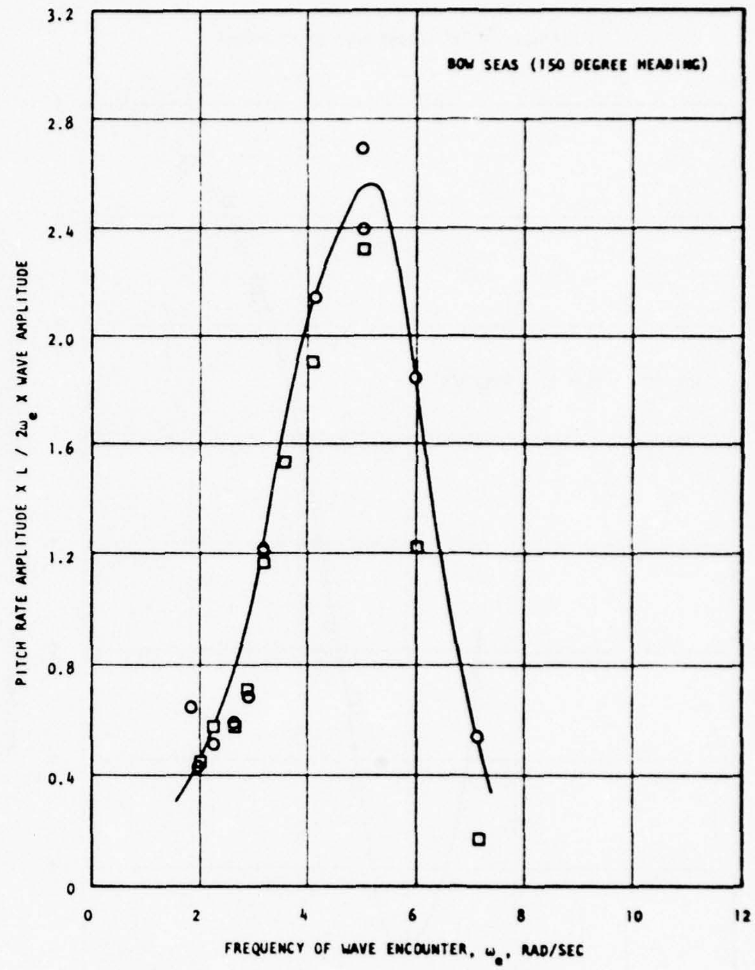


Figure 11f - Pitch Rate Transfer Function

Figure 11 - Concluded

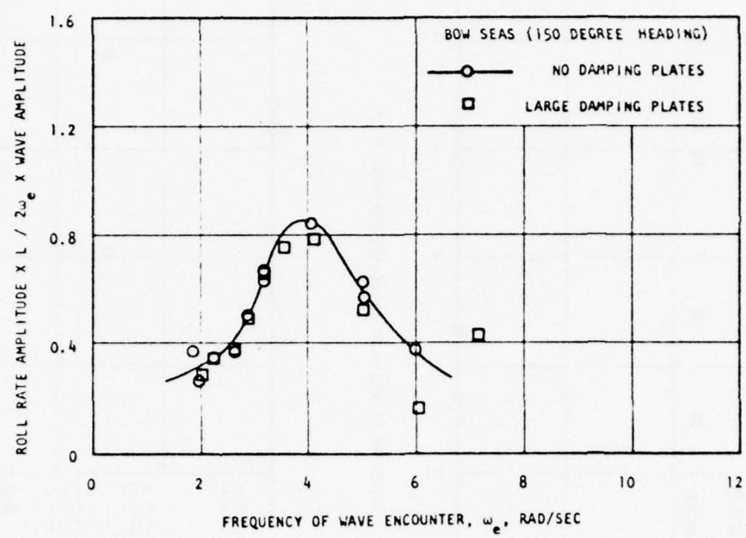


Figure 11g - Roll Rate Transfer Function

Figure 12 - Responses in Regular Waves Versus Speed from Phase 1

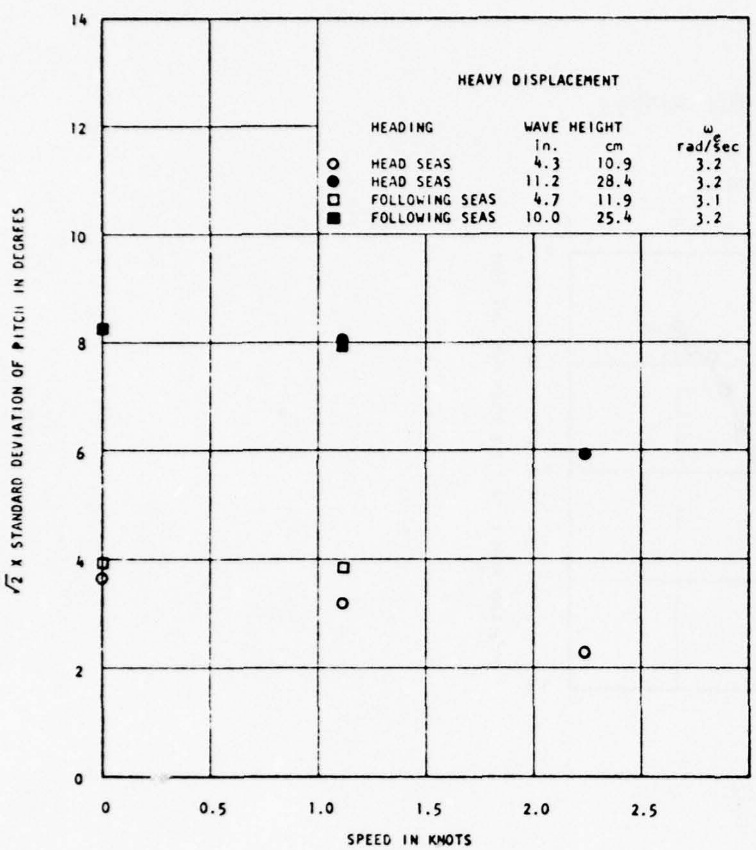


Figure 12a - Pitch for Heavy Displacement

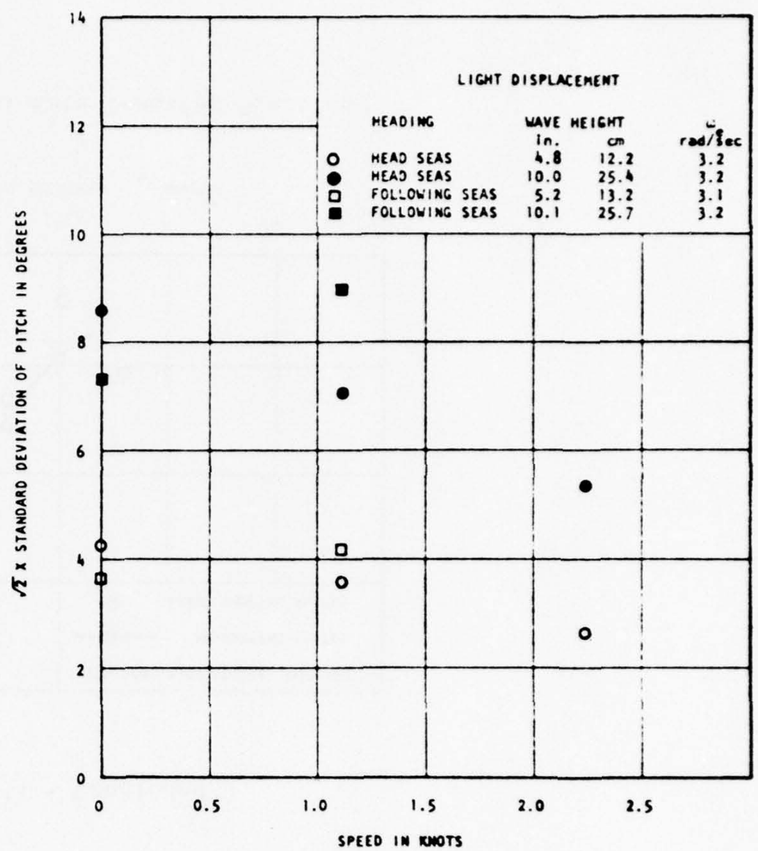


Figure 12b - Pitch for Light Displacement

Figure 12 - Continued

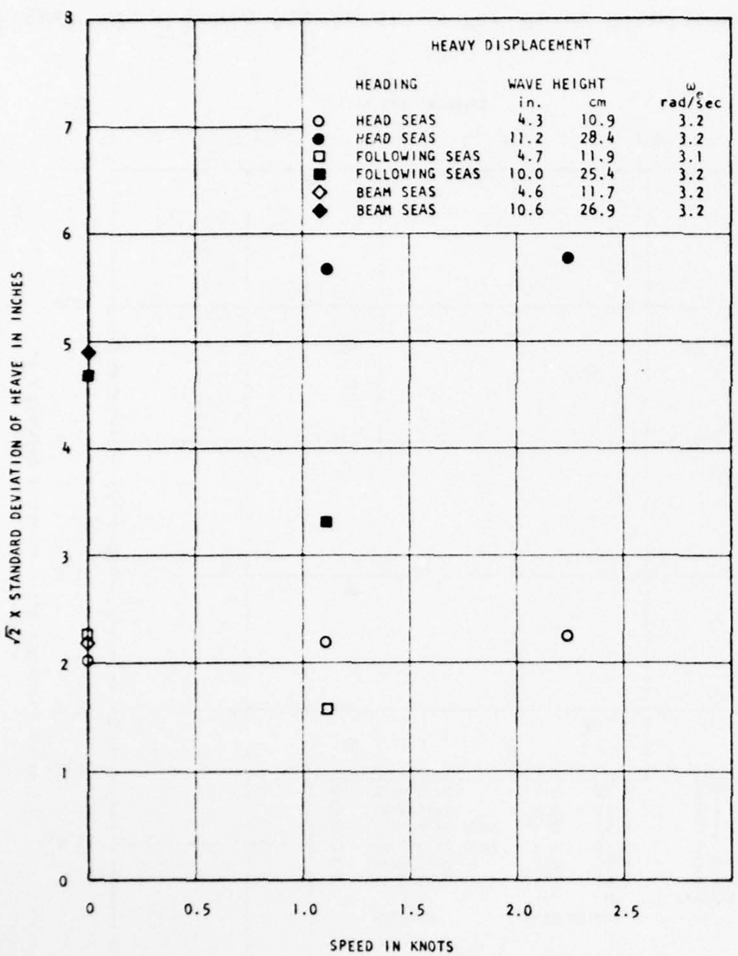


Figure 12c - Heave for Heavy Displacement

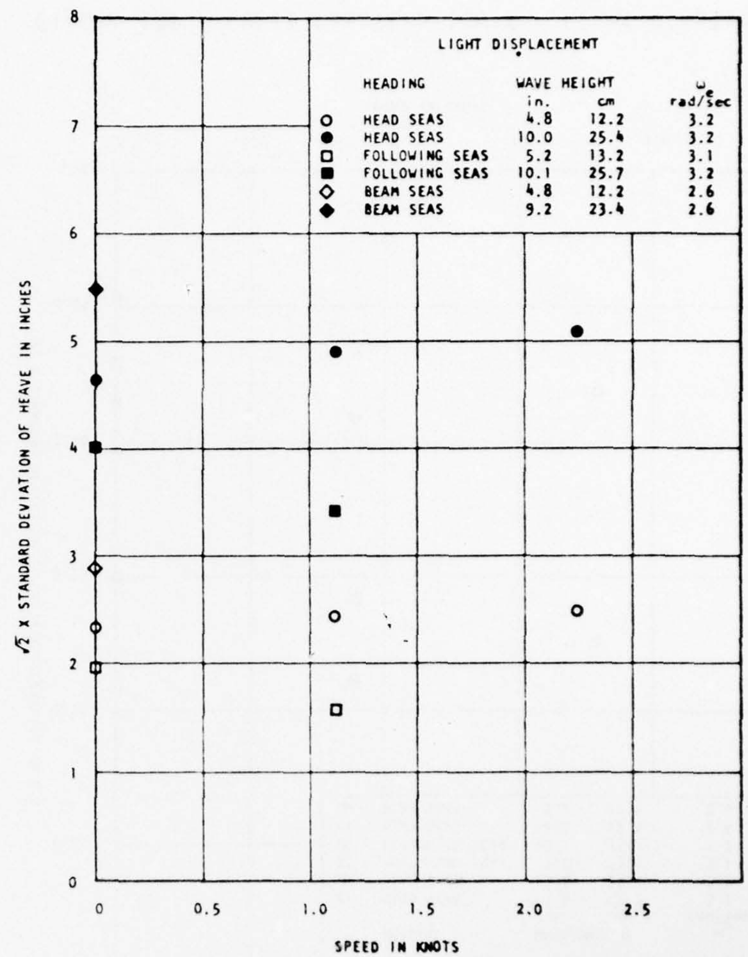


Figure 12d - Heave for Light Displacement

Figure 12 - Continued

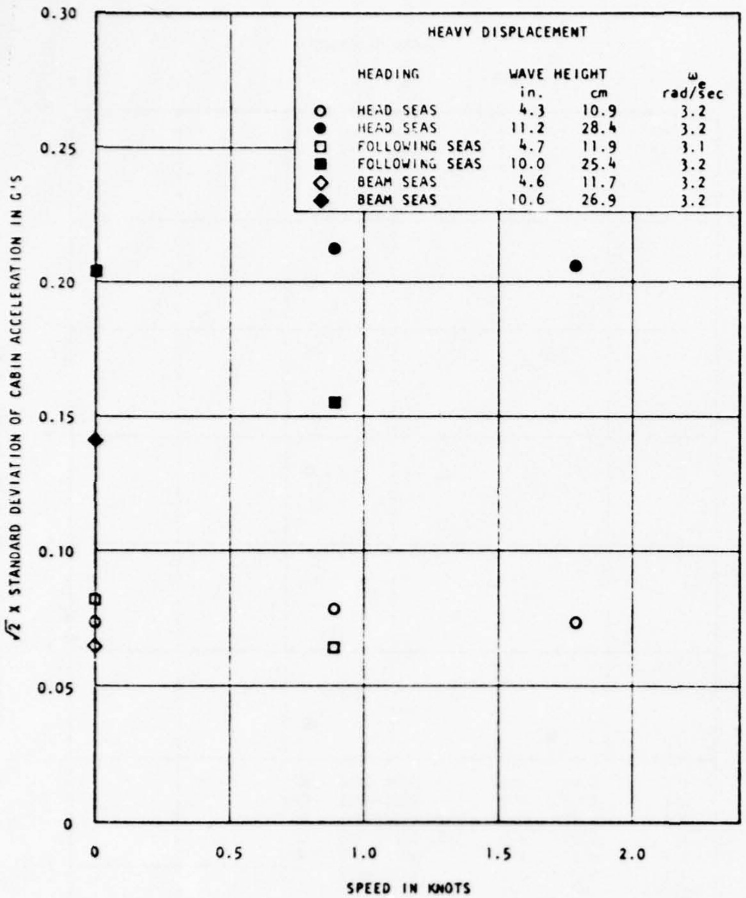


Figure 12e - Cabin Acceleration for Heavy Displacement

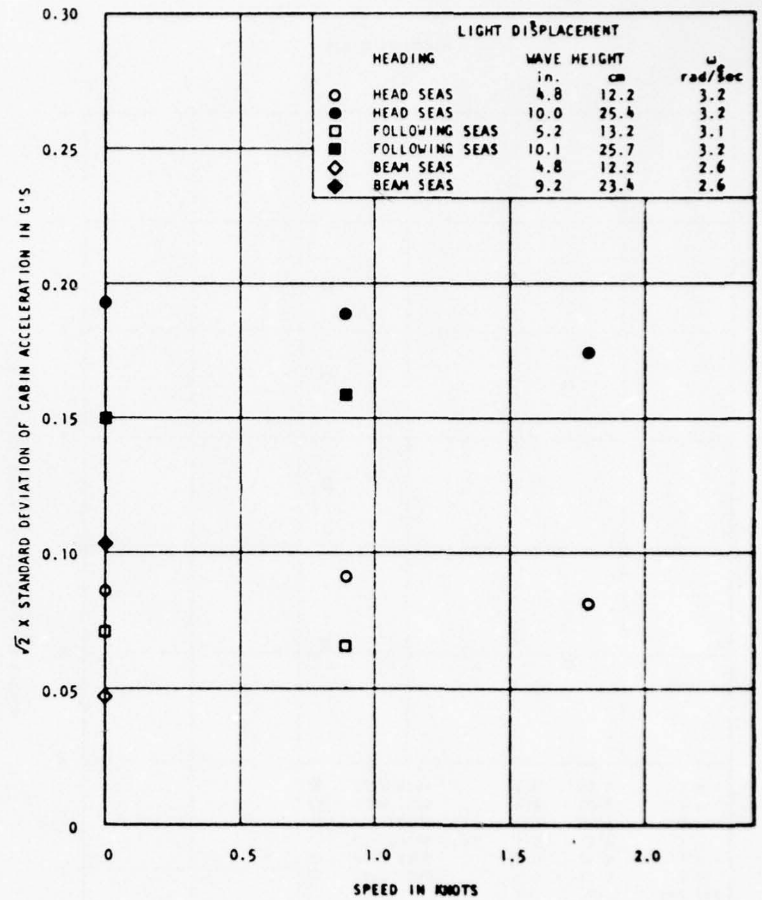


Figure 12f - Cabin Acceleration for Light Displacement

Figure 12 - Continued

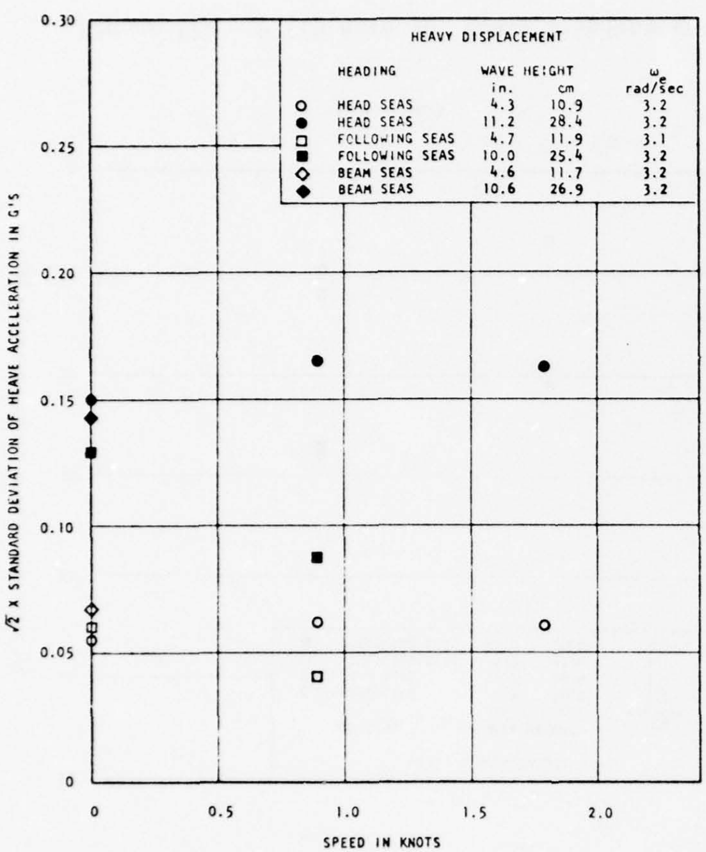


Figure 12g - Heave (CG) Acceleration for Heavy Displacement

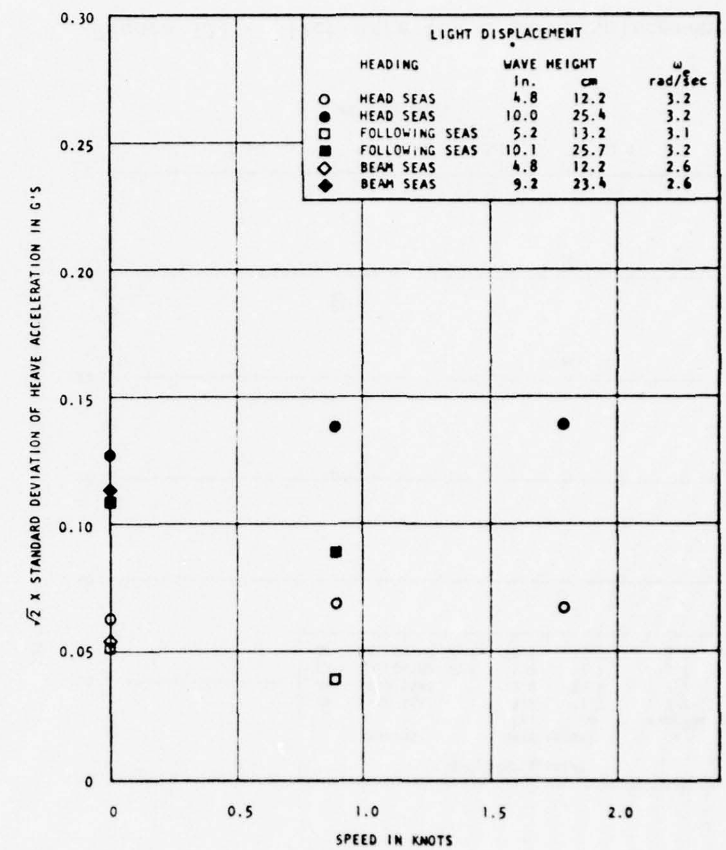


Figure 12h - Heave (CG) Acceleration for Light Displacement

Figure 12 - Concluded

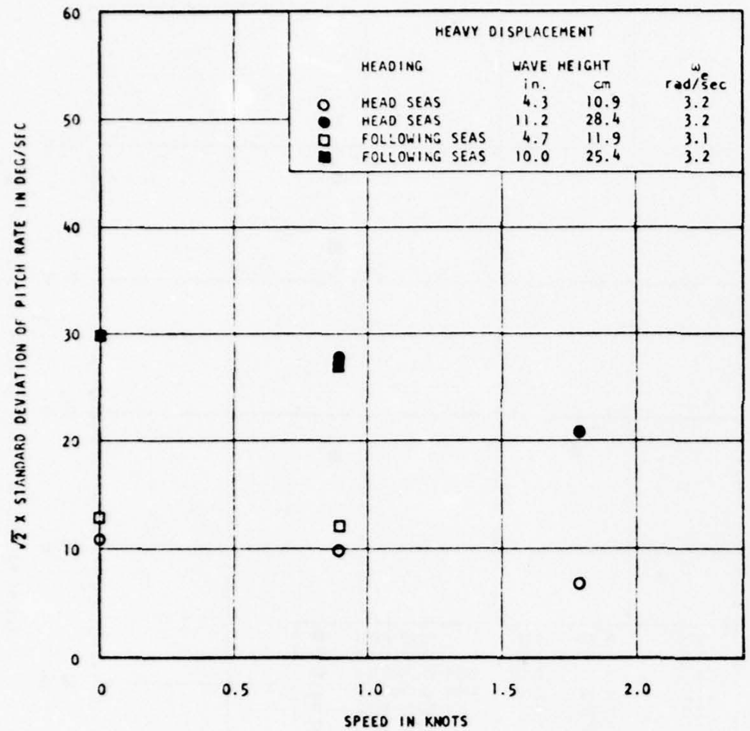


Figure 12i - Pitch Rate for Heavy Displacement

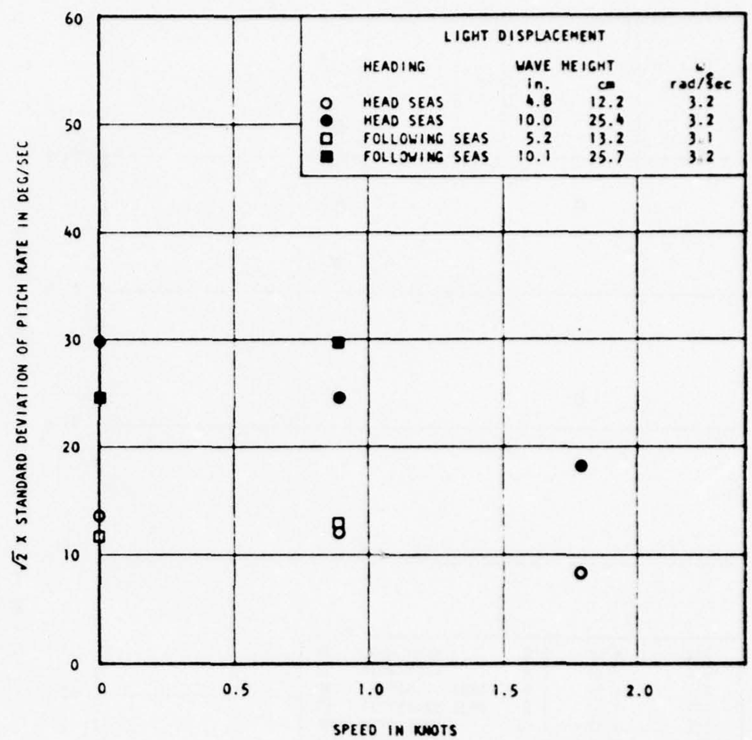


Figure 12j - Pitch Rate for Light Displacement

Figure 13 - Sample Computer Printout from Real-Time Analysis of Random Wave Run

MASK SEA LOITER : SEAPLANE AND MOORING BUOY 18 SEPT 1976

SEAPLANE TEST SEGMENT

NOMN SEA STATE 3

HEADING = 180.0 DEG

MEAS SPEED = 1.79 KNOTS
NOMN SPEED = 1.79 KNOTS

RUN NO 147

TIME: 0.000 - 43.000
RECORDS: 1 - 32

	CHAN		CALIB	GAIN	MEAN	STDDEV	ROOTOO
1	WAVE HT	IN	4.000E 00	2.000E 00	3.407E-02	2.860E 00	4.045E 00
2	HEAVE	IN	4.000E 00	2.000E 00	9.872E-02	2.693E 00	3.808E 00
3	PITCH	DEG	1.000E 01	5.000E 00	-2.882E-02	3.714E 00	5.253E 00
4	ROLL	DEG	1.000E 01	5.000E 00	2.557E-02	4.085E-01	5.777E-01
5	DRAG	LBS	4.000E 01	2.000E 00	-1.917E 00	1.479E 01	2.092E 01
6	PITCH RT	DPS	3.000E 01	5.000E 00	-1.004E-01	1.975E 01	2.793E 01
7	ROLL RT	DPS	3.000E 01	5.000E 00	1.687E-01	2.391E 00	3.381E 00
8	HEAVEACC	G	2.000E 00	4.000E 00	-3.433E-03	1.119E-01	1.582E-01
9	CABINACC	G	4.000E 00	4.000E 00	-2.534E-03	1.967E-01	2.782E-01
10	CARR SPD	KTS	1.000E 00	1.000E 00	1.732E 00	7.042E-03	9.959E-03

RUN 147.

NO OF CYCLES = 27 AVERAGE PERIOD = 1.7136 SEC

MAX PERIOD = 2.582 SEC
AVG PERIOD = 1.714 SEC
MIN PERIOD = 0.740 SEC

MAX DBL AMP = 8.300
AVG DBL AMP = 3.621
MIN DBL AMP = 1.304

BEST AVAILABLE COPY

Figure 14 - Sample of Complete Random Wave Run Analysis on the CDC 6700 Computer

RANDOM WAVE DATA *** RUN 592 HEAD SEAS 0 KNOTS *** TAPE RECORD 2

SEA STATE 3 (NOMINAL) SCAN RATE = 8.00 SAMPLES/SEC/CHAN
BELOW SEA STATE 2 (COMPUTED) RUN TIME = 3.93 MINUTES

SMALL DAMPING PLATES

CHANNEL	1	2	3	4	5	6	7	8	9
TITLE	WAVEHT	HEAVE	SWAY	SURGE	PITCH	ROLL	YAW	HEAVAC	CGSNAC
UNIT	FEET	FEET	FEET	FEET	DEG	DEG	DEG	G	G
SCALE FACTOR	8.3333E-02	8.3333E-02	8.3333E-02	8.3333E-02	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
CAL (PU/VT)	1.6667E+01	2.0000E+00	1.2000E+01	1.2000E+01	4.0000E+00	6.6668E+00	4.0000E+00	2.5000E-01	1.0000E+00
CAL (VT/CT)	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
ATTENUATION	X 5.0	X 5.0	X 2.0	X 2.0	X .25	X .25	X .25	X 4.0	X 4.0
RUN MEAN	1.9733E-03	-6.2759E-03	1.0454E+00	-3.9634E-01	2.5547E-01	-2.6051E-01	2.7668E-01	-1.0741E-03	-1.3513E-03
RUN ROOTOG	1.9050E-01	1.4143E-01	1.1008E+00	6.6202E-01	4.1374E+00	1.3114E+00	4.7337E+00	4.8788E-02	1.2482E-01

CHANNEL	10	11	12	13
TITLE	WINGAC	PITCRT	ROLLRT	YAW RT
UNIT	G	RAD/SEC	RAD/SEC	RAD/SEC
SCALE FACTOR	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
CAL (PU/VT)	1.0000E+00	6.0000E+00	6.0000E+00	4.0000E+00
CAL (VT/CT)	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
ATTENUATION	X 4.0	X .25	X .25	X .05
RUN MEAN	-5.1161E-03	1.1740E+00	4.4275E-02	3.5942E-02
RUN ROOTOG	7.7961E-02	1.7790E+01	3.1018E+00	1.7368E+00

Figure 14 - Sheet a

CROSS - SPECTRA

PITCH * WAVEHT (DEG *FEET)*SEC

OMEGAS (RAD/SEC)	CO - SPECTRUM	QUAD - SPECTRUM	MAGNITUDE SPECTRUM	PHASE (DEG)	COHERENCY FUNCTION
.419	-5.2703E-04	1.7024E-04	5.5384E-04	-198.1	.128
.838	-5.2234E-04	6.0943E-04	8.0116E-04	-229.9	.260
1.257	-1.7899E-03	5.4636E-03	5.7493E-03	-252.4	.693
1.676	-4.7269E-03	2.0525E-02	2.1108E-02	-257.2	.791
2.094	-5.7246E-03	5.7036E-02	5.7323E-02	-265.2	.780
2.513	-7.2419E-03	1.1612E-01	1.1635E-01	-267.5	.853
2.932	-1.7205E-02	1.5502E-01	1.5597E-01	-265.0	.862
3.351	-1.5579E-02	1.8127E-01	1.8194E-01	-266.6	.877
3.770	-7.2983E-03	2.1011E-01	2.1024E-01	-268.7	.883
4.189	-8.4356E-03	2.1226E-01	2.1244E-01	-269.6	.787
4.608	1.3904E-02	1.8227E-01	1.8279E-01	85.6	.726
5.027	4.3753E-02	1.1417E-01	1.2227E-01	65.8	.680
5.445	5.1139E-02	6.0439E-02	7.9523E-02	47.6	.654
5.864	4.2357E-02	4.0898E-02	5.7457E-02	42.8	.605
6.283	1.5737E-02	1.8031E-02	2.4311E-02	46.9	.487
6.702	1.3734E-03	5.0439E-03	5.1567E-03	75.0	.319
7.121	-1.7116E-04	1.3949E-03	1.4054E-03	-266.1	.137
7.540	[illegible]	8.9117E-05	9.0147E-05	77.0	.003
7.959	2.4159E-05	-7.1508E-05	7.6916E-05	-72.1	.005
8.378	5.1929E-05	-1.4641E-04	1.5444E-04	-74.0	.030
8.796	1.5094E-04	-1.5136E-04	2.2094E-04	-47.1	.173
9.215	9.3767E-05	-1.0356E-04	1.4813E-04	-51.7	.680
9.634	5.8779E-05	-1.2016E-05	6.0095E-05	-16.3	.267

HEAVE * WAVEHT (FEET *FEET)*SEC

OMEGAS (RAD/SEC)	CO - SPECTRUM	QUAD - SPECTRUM	MAGNITUDE SPECTRUM	PHASE (DEG)	COHERENCY FUNCTION
.419	-1.9380E-05	-1.0708E-05	2.2142E-05	-151.1	.181
.838	-1.4370E-04	-2.0037E-05	1.4508E-04	-172.2	.505
1.257	-1.2631E-03	-1.1847E-04	1.2686E-03	-174.8	.925
1.676	-3.7488E-03	-3.5549E-04	3.7656E-03	-174.8	.961
2.094	-6.8199E-03	-2.1887E-04	6.8234E-03	-178.4	.951
2.513	-9.2447E-03	5.9981E-05	9.2449E-03	-180.6	.941
2.932	-9.0747E-03	-3.6095E-04	9.0819E-03	-178.0	.940
3.351	-7.5125E-03	-3.9819E-04	7.5230E-03	-177.3	.931
3.770	-6.3082E-03	2.1040E-05	6.3092E-03	-180.6	.874
4.189	-4.5994E-03	-2.5687E-04	4.6066E-03	-177.3	.816
4.608	-2.9303E-03	-3.1537E-04	2.9552E-03	-174.4	.786
5.027	-1.5510E-03	1.4976E-04	1.5582E-03	-186.1	.663
5.445	-4.0627E-04	2.4458E-04	4.7421E-04	-211.6	.259
5.864	1.0936E-04	-5.8197E-05	1.2388E-04	-28.7	.037
6.283	1.8526E-04	-2.1323E-04	2.8247E-04	-49.7	.327
6.702	4.2470E-05	-8.2274E-05	9.2589E-05	-63.4	.132
7.121	-2.4187E-05	3.4784E-06	2.4429E-05	-188.9	.057
7.540	-1.8939E-05	3.3908E-06	1.9240E-05	-191.0	.081
7.959	-1.1746E-05	7.5137E-06	1.3944E-05	-213.5	.056
8.378	-3.6263E-06	3.2946E-06	4.8993E-06	-223.2	.008
8.796	-5.1644E-06	-6.7222E-06	8.4769E-06	-128.5	.033
9.215	-7.2300E-06	-9.1305E-06	1.1646E-05	-129.4	.097
9.634	-3.8646E-06	-4.4998E-06	5.9316E-06	-131.7	.045

Figure 14 - Sheet b

CROSS - SPECTRA

OMEGAE (RAD/SEC)	ROLL * WAVEHT (DEG *FEET)*SEC CO - SPECTRUM	QUAD - SPECTRUM	MAGNITUDE SPECTRUM	PHASE (DEG)	COHERENCY FUNCTION
.419	-3.9713E-05	-1.8215E-05	4.3691E-05	-155.6	.002
.838	-1.7722E-05	1.2597E-04	1.2721E-04	-262.5	.017
1.257	-1.4324E-03	1.6244E-03	2.1658E-03	-229.3	.513
1.676	-2.9276E-03	5.4237E-03	6.1165E-03	-243.4	.494
2.094	2.2439E-03	4.4776E-03	4.9727E-03	63.0	.079
2.513	2.9939E-03	-6.5114E-03	7.1255E-03	-67.4	.069
2.932	-5.6776E-03	-6.6309E-03	8.7447E-03	-132.1	.079
3.351	-4.2623E-03	-3.0864E-03	5.2624E-03	-145.9	.019
3.770	-1.1546E-02	-1.3297E-02	1.7609E-02	-131.0	.102
4.189	-1.9013E-02	-2.1326E-03	1.9132E-02	-175.9	.093
4.608	2.7382E-03	1.1089E-02	1.1421E-02	73.6	.042
5.027	1.3078E-02	-4.3297E-03	1.3776E-02	-21.1	.089
5.445	1.9757E-03	-8.9541E-03	9.1485E-03	-81.2	.051
5.864	-4.3068E-03	-1.0970E-03	4.4419E-03	-169.1	.013
6.283	-5.6654E-03	-2.0220E-03	5.9316E-03	-163.2	.040
6.702	-3.5147E-03	-3.5573E-03	5.0079E-03	-134.3	.074
7.121	-6.4336E-04	-1.4215E-03	1.4990E-03	-111.2	.015
7.540	-2.1973E-04	-5.8622E-05	2.2645E-04	-169.2	.001
7.959	-4.3925E-04	-1.2125E-04	4.5542E-04	-169.1	.014
8.379	-2.8019E-04	-2.7519E-04	3.9273E-04	-143.1	.017
8.796	-2.9923E-04	-1.0007E-04	3.1457E-04	-166.3	.032
9.215	-1.9443E-05	1.9645E-05	2.7782E-05	-230.7	.001
9.634	2.1272E-05	-1.1536E-05	2.4199E-05	-33.8	.001

OMEGAE (RAD/SEC)	PITCRT * WAVEHT (RPS *FEET)*SEC CO - SPECTRUM	QUAD - SPECTRUM	MAGNITUDE SPECTRUM	PHASE (DEG)	COHERENCY FUNCTION
.419	-4.3559E-04	-1.0501E-04	4.4878E-04	-166.5	.174
.838	-1.0385E-03	-3.9274E-04	1.1079E-03	-160.8	.470
1.257	-9.5434E-03	-2.8927E-03	9.9722E-03	-164.9	.752
1.676	-3.8522E-02	-7.4409E-03	3.9214E-02	-170.9	.739
2.094	-1.3011E-01	-4.1407E-03	1.3017E-01	-180.5	.768
2.513	-3.0770E-01	-5.1227E-03	3.0774E-01	-181.0	.816
2.932	-4.6114E-01	-3.0881E-02	4.6217E-01	-179.4	.814
3.351	-6.1774E-01	-9.0178E-03	6.1781E-01	-182.9	.837
3.770	-7.9548E-01	2.7039E-02	7.9594E-01	-186.1	.867
4.189	-8.9953E-01	2.6357E-02	8.8992E-01	-186.3	.757
4.608	-8.2356E-01	1.3087E-01	8.3469E-01	-194.4	.714
5.027	-5.3458E-01	2.6576E-01	5.9700E-01	-212.0	.684
5.445	-3.0168E-01	3.0157E-01	4.2656E-01	-231.0	.674
5.864	-2.1375E-01	2.4927E-01	3.2833E-01	-235.8	.625
6.283	-1.0335E-01	1.0336E-01	1.4616E-01	-231.9	.499
6.702	-3.2436E-02	9.8098E-03	3.3887E-02	-234.2	.315
7.121	-9.9396E-03	-7.2064E-04	9.9647E-03	-183.7	.142
7.540	-1.0931E-03	-2.5301E-04	1.1220E-03	-175.3	.039
7.959	3.6905E-04	-8.7061E-04	9.4560E-04	-75.8	.016
8.379	1.1458E-03	-7.8129E-04	1.3869E-03	-43.5	.057
8.796	1.3899E-03	6.7021E-04	1.5421E-03	16.1	.107
9.215	9.1211E-04	8.9707E-04	1.2793E-03	34.4	.223
9.634	1.0294E-04	5.0353E-04	5.1395E-04	67.8	.267

Figure 14 - Sheet c

CROSS - SPECTRA

PITCH * PITCRT
(DEG * RPS)*SEC

OMEGAE (RAD/SEC)	CO - SPECTRUM	QUAD - SPECTRUM	MAGNITUDE SPECTRUM	PHASE (DEG)	COHERENCY FUNCTION
.419	1.7155E-02	-7.2263E-03	1.8615E-02	-22.6	3.128
.838	1.2606E-02	-1.1176E-02	1.6846E-02	-41.6	3.609
1.257	1.2570E-02	-5.5659E-02	5.7092E-02	-76.3	1.077
1.676	2.6937E-02	-2.7158E-01	2.7292E-01	-83.2	1.001
2.094	8.6619E-02	-1.3874E+00	1.3901E+00	-85.0	.985
2.513	1.9182E-01	-4.0847E+00	4.0592E+00	-85.6	.991
2.932	4.2946E-01	-7.8872E+00	7.8991E+00	-85.0	.990
3.351	9.8739E-01	-1.4610E+01	1.4652E+01	-83.9	.993
3.770	1.6077E+00	-2.2528E+01	2.2585E+01	-83.4	.995
4.189	2.3835E+00	-3.2191E+01	3.2280E+01	-83.0	.996
4.608	2.9426E+00	-3.7415E+01	3.7530E+01	-82.5	.997
5.027	2.2271E+00	-2.6850E+01	2.6942E+01	-81.9	.997
5.445	1.2276E+00	-1.4164E+01	1.4216E+01	-81.5	.997
5.864	6.5023E-01	-7.6220E+00	7.6520E+00	-81.2	.997
6.283	2.1189E-01	-2.3261E+00	2.3358E+00	-80.6	.997
6.702	2.8203E-02	-3.6207E-01	3.6317E-01	-81.1	.993
7.121	4.7570E-03	-1.2598E-01	1.2597E-01	-83.1	.980
7.540	-1.0919E-03	-3.6941E-02	3.6958E-02	-86.7	.976
7.959	-1.2363E-03	-2.0710E-02	2.0747E-02	-88.2	.951
8.379	-1.2503E-03	-9.1197E-03	9.2050E-03	-92.3	1.142
8.796	-1.1066E-03	-8.3497E-03	8.4227E-03	-91.7	1.075
9.215	-1.9554E-03	-3.0959E-03	3.6618E-03	-115.2	2.450
9.634	-1.8823E-03	-1.9634E-03	2.7199E-03	-127.4	3.885

Figure 14 - Sheet d

RUNS 592 - 592 HEAD SEAS 0 KNOTS
SMALL DAMPING PLATES

SEA STATE 3 (NOMINAL) 64.23 DEGREES OF FREEDOM
SERIES TIME = 3.98 MINUTES NO OF SPLICES / SERIES = 0

STATISTICAL PROPERTIES

CHANNEL	1	2	3	4	5	6	7	8	9
TITLE	WAVEHT	HEAVE	SWAY	SURGE	PITCH	ROLL	YAW	HEAVAC	CABNAC
UNIT	FEET	FEET	FEET	FEET	DEG	DEG	DEG	G	G
ROOT E	1.8719E-01	1.4135E-01	2.7075E-02	1.2162E-01	4.1359E+00	1.3035E+00	2.5106E-01	4.8717E-02	1.2396E-01
ROOT 00	1.9060E-01	1.4143E-01	1.1024E+00	6.8202E-01	4.1374E+00	1.3114E+00	4.7337E+00	4.8760E-02	1.2402E-01
AVERAGE	3.3132E-01	2.5019E-01	4.7922E-02	2.1526E-01	7.3206E+00	2.3072E+00	4.4438E-01	8.6228E-02	2.1940E-01
SIGNIFICANT	5.2974E-01	4.0002E-01	7.6622E-02	3.4418E-01	1.1705E+01	3.6890E+00	7.1050E-01	1.3787E-01	3.5090E-01
AVE.HIGH.1/10	6.7397E-01	5.0895E-01	9.7469E-02	4.3782E-01	1.4899E+01	4.6927E+00	9.0381E-01	1.7538E-01	4.4625E-01
HI. EXP. 100	9.0116E-01	6.0497E-01	1.1588E-01	5.2053E-01	1.7702E+01	5.5791E+00	1.0745E+00	2.0851E-01	5.3054E-01
ROOTE/ROOT00	9.8209E-01	9.9942E-01	2.4595E-02	1.8371E-01	9.9964E-01	9.9401E-01	5.3037E-02	9.9870E-01	9.9952E-01

POWER SPECTRA

SPECTRUM SCALE	2.0000E-02	1.0000E-02	1.0000E-03	1.0000E-02	1.0000E+01	1.0000E+00	5.0000E-02	1.0000E-03	1.0000E-02
SPECTRUM PEAK	1.0843E-02	9.6340E-03	9.0791E-04	5.8364E-03	8.1659E+00	5.5171E-01	2.7448E-02	9.7850E-04	8.3334E-03
PEAK FREQUENCY	2.9322E+00	2.5133E+00	9.2153E+00	4.6077E+00	4.6077E+00	4.6077E+00	4.1888E+00	3.7699E+00	4.6077E+00

OMEGAE (RAD/SEC)	WAVEHT (FEET)2*SEC	HEAVE (FEET)2*SEC	SWAY (FEET)2*SEC	SURGE (FEET)2*SEC	PITCH (DEG)2*SEC	ROLL (DEG)2*SEC	YAW (DEG)2*SEC	HEAVAC (G)2*SEC	CABNAC (G)2*SEC
.419	1.5820E-04	1.7151E-05	1.1058E+00	5.0902E-01	1.5129E-02	7.3782E-03	2.6475E+01	1.3349E-06	2.1126E-06
.838	2.8197E-04	1.4776E-04	4.9386E-01	6.2776E-02	8.5031E-03	3.4058E-03	8.0381E+00	1.7357E-06	2.3548E-06
1.257	1.4437E-03	1.2000E-03	1.9321E-01	-1.2452E-03	3.3057E-02	6.3388E-03	2.0963E-01	8.7673E-06	8.6917E-06
1.676	3.9677E-03	3.7185E-03	1.0995E-01	4.5716E-03	1.4194E-01	1.9482E-02	1.8690E-01	4.5458E-05	4.3646E-05
2.094	7.1711E-03	6.8256E-03	7.3810E-02	2.3962E-03	5.8745E-01	4.3891E-02	1.1742E-02	1.6213E-04	1.9791E-04
2.513	1.0521E-02	8.6340E-03	4.4447E-02	2.3199E-03	1.5094E+00	7.0233E-02	2.4498E-02	3.5995E-04	5.0332E-04
2.932	1.0843E-02	8.0949E-03	3.1157E-02	8.0698E-04	2.6037E+00	8.9072E-02	5.9948E-03	5.7014E-04	9.7514E-04
3.351	9.9214E-03	6.8107E-03	2.6541E-02	7.2141E-04	4.2323E+00	1.6090E-01	1.4941E-02	8.2528E-04	1.9270E-03
3.770	9.4426E-03	5.3922E-03	2.1787E-02	1.6032E-03	5.9272E+00	3.6167E-01	1.8649E-02	9.7850E-04	3.2765E-03
4.189	7.5554E-03	3.4439E-03	1.5000E-02	4.0334E-03	7.5876E+00	5.2239E-01	2.7448E-02	9.2756E-04	5.9171E-03
4.608	5.6395E-03	1.9719E-03	8.8460E-03	5.9364E-03	8.1639E+00	5.5171E-01	1.5381E-02	7.7898E-04	8.3334E-03
5.027	3.9632E-03	9.2458E-04	5.5731E-03	4.9464E-03	5.5400E+00	5.3948E-01	1.0315E-02	4.5841E-04	6.9461E-03
5.445	3.5796E-03	2.4266E-04	3.9576E-03	3.2073E-03	2.6455E+00	4.6138E-01	7.9420E-03	1.6969E-04	4.2837E-03
5.864	4.0523E-03	1.0324E-04	3.0236E-03	1.8838E-03	1.3436E+00	3.6492E-01	5.2915E-03	1.1369E-04	2.5602E-03
6.283	3.0837E-03	7.9260E-05	2.4564E-03	6.6473E-04	3.9370E-01	2.8578E-01	2.0329E-03	1.1601E-04	1.0871E-03
6.702	1.5134E-03	4.2774E-05	1.7054E-03	2.2928E-04	5.5120E-02	2.2319E-01	1.5689E-03	6.6924E-05	3.4511E-04
7.121	7.8477E-04	1.3377E-05	1.2041E-03	1.5263E-04	1.8299E-02	1.7462E-01	4.6398E-04	2.0243E-05	1.1835E-04
7.540	4.7733E-04	9.6059E-06	1.0562E-03	1.8047E-04	4.9662E-03	9.9935E-02	3.2037E-04	1.6167E-05	5.5759E-05
7.959	3.5237E-04	9.8365E-06	1.0077E-03	2.1644E-04	7.7897E-03	4.3391E-02	-3.2995E-05	1.9557E-05	4.3854E-05
8.378	3.6837E-04	8.1833E-06	8.5602E-04	1.9941E-04	8.0915E-04	7.4703E-02	1.4768E-04	1.3457E-05	2.7996E-05
8.796	3.0837E-04	7.1060E-06	8.3773E-04	1.7825E-04	9.1314E-04	1.0041E-02	1.4905E-05	6.3851E-06	1.5398E-05
9.215	2.0807E-04	6.7095E-06	9.0791E-04	1.5553E-04	1.5498E-04	4.1611E-03	1.5900E-04	4.4178E-06	6.9525E-06
9.634	1.6748E-04	4.7094E-06	7.8065E-04	9.2937E-05	8.0911E-05	6.8964E-03	4.9271E-06	3.2623E-06	4.2515E-06

Figure 14 - Sheet e

STATISTICAL PROPERTIES

CHANNEL	10	11	12	13	8	9	10
TITLE	WINGAC	PITCRT	ROLLRT	YAW RT	HEAVAC	CARNAC	WINGAC
UNIT	G	RAD/SEC	RAD/SEC	RAD/SEC	FEET	FEET	FEET
ROOT E	7.5573E-02	1.7787E+01	3.0579E+00	7.5076E-01	1.4740E-01	2.3976E-01	1.6519E-01
ROOT 02	7.7953E-02	1.7790E+01	3.1018E+00	1.7368E+00	0.	0.	0.
AVERAGE	1.3376E-01	3.1494E+01	5.4124E+00	1.3288E+00	2.6089E-01	4.2438E-01	2.9238E-01
SIGNIFICANT	2.1397E-01	5.0338E+01	8.6538E+00	2.1247E+00	4.1713E-01	6.7852E-01	4.6748E-01
AVE.HIGH.1/10	2.7236E-01	6.4034E+01	1.1009E+01	2.7027E+00	5.3063E-01	8.6314E-01	5.9467E-01
HI. EXP. 100	3.2345E-01	7.6130E+01	1.3088E+01	3.2133E+00	6.3096E-01	1.0262E+00	7.0700E-01
ROOTE/ROOT02	9.6935E-01	9.9984E-01	9.8584E-01	4.3227E-01	0.	0.	0.

POWER SPECTRA

SPECTRUM SCALE	2.0000E-03	2.0000E+02	5.0000E+00	2.5000E-01	1.0000E-02	2.0000E-02	2.0000E-02
SPECTRUM PEAK	1.4492E-03	1.7299E+02	2.9005E+00	2.2219E-01	9.3387E-03	1.9896E-02	1.0426E-02
PEAK FREQUENCY	5.0265E+00	4.6077E+00	5.4454E+00	4.1888E+00	2.5133E+00	4.1888E+00	2.5133E+00

OMEGAE (RAD/SEC)	WINGAC (G)2*SEC	PITCRT (RPS)2*SEC	ROLLRT (RPS)2*SEC	YAW RT (RPS)2*SEC	HEAVAC (FEET)2*SEC	CARNAC (FEET)2*SEC	WINGAC (FEET)2*SEC
.419	1.5772E-06	7.3217E-03	8.3615E-04	2.3945E+00	4.4895E-02	7.1037E-02	5.3033E-02
.838	2.0578E-06	9.2473E-03	2.4965E-03	1.3359E+00	3.6476E-03	4.9497E-03	4.3245E-03
1.257	8.8578E-06	9.1572E-02	6.2934E-03	3.9797E-01	3.6395E-03	3.6081E-03	3.6749E-03
1.676	4.7445E-05	5.2411E-01	2.1478E-02	2.2489E-01	5.9707E-03	6.5218E-03	6.2317E-03
2.094	1.9084E-04	3.3379E+00	6.3217E-02	1.0353E-01	8.7223E-03	1.0642E-02	1.0267E-02
2.513	4.0136E-04	1.1025E+01	1.5651E-01	6.9978E-02	9.3397E-03	1.3059E-02	1.0426E-02
2.932	5.9496E-04	2.4195E+01	2.1963E-01	6.5785E-02	7.9845E-03	1.3656E-02	8.3319E-03
3.351	9.9837E-04	5.1102E+01	5.7366E-01	9.1075E-02	6.7748E-03	1.5819E-02	8.1958E-03
3.770	1.2539E-03	8.6512E+01	1.4916E+00	1.9914E-01	5.0147E-03	1.6792E-02	6.4513E-03
4.189	1.1517E-03	1.3920E+02	1.8571E+00	2.2219E-01	3.1189E-03	1.9896E-02	3.8725E-03
4.608	1.3172E-03	1.7299E+02	1.9971E+00	1.6068E-01	1.7890E-03	1.9132E-02	3.0250E-03
5.027	1.4492E-03	1.3144E+02	2.7284E+00	1.8721E-01	7.4334E-04	1.1264E-02	2.3483E-03
5.445	1.2246E-03	7.5478E+01	2.9005E+00	1.8070E-01	1.9977E-04	5.0431E-03	1.4417E-03
5.864	1.0338E-03	4.2548E+01	2.5090E+00	1.0728E-01	9.9510E-05	2.2419E-03	9.0456E-04
6.283	9.0527E-04	1.3901E+01	2.1767E+00	6.6687E-02	7.7050E-05	7.2203E-04	6.0127E-04
6.702	8.4738E-04	2.4097E+00	1.9210E+00	4.6001E-02	3.4336E-05	1.7706E-04	4.3506E-04
7.121	8.0559E-04	8.8448E-01	1.6438E+00	2.5440E-02	8.1494E-06	4.7646E-05	3.2432E-04
7.540	5.7572E-04	2.8245E-01	1.0134E+00	1.1905E-02	5.1795E-06	1.7863E-05	1.8441E-04
7.959	3.5334E-04	1.6732E-01	4.9634E-01	6.8535E-03	5.0459E-06	1.1315E-05	9.1166E-05
8.378	2.4161E-04	9.1730E-02	3.1757E-01	4.1588E-03	2.9291E-06	5.8835E-06	5.0776E-05
8.796	1.0775E-04	7.2242E-02	1.3447E-01	2.1413E-03	1.1639E-06	2.6822E-06	1.8629E-05
9.215	6.6763E-05	3.5316E-02	6.0194E-02	1.7637E-03	6.3412E-07	9.9795E-07	9.5930E-06
9.634	1.0765E-04	2.3537E-02	9.7879E-02	1.8008E-03	3.9199E-07	5.1084E-07	1.2935E-05

Figure 14 - Sheet f

RESPONSE AMPLITUDE OPERATORS

5 PERCENT AMPLITUDE RANGES

	WAVEHT	HEAVE	SWAY	SURGE	PITCH	ROLL	YAW	HEAVAC	CABNAC
FREQ. RANGE 1	1.26- 7.12	1.26- 5.03	8.80- 9.63	1.68- 5.28	2.09- 5.86	2.09- 7.96	2.09- 6.70	2.09- 6.70	2.51- 6.28
2	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00

OMEGAE	WAVEHT SPECTRUM	HEAVE / WAVEHT	SWAY / WAVEHT	SURGE / WAVEHT	PITCH / WAVEHT	ROLL / WAVEHT	YAW / WAVEHT	HEAVAC / WAVEHT	CABNAC / WAVEHT
.419	1.5820E-04	1.0941E-01	6.9901E+03	3.2177E+03	9.5637E+01	4.6639E+01	1.6736E+05	8.4391E-03	1.3355E-02
.838	2.8197E-04	5.2404E-01	1.7515E+03	2.2263E+02	3.0156E+01	1.2078E+01	2.8507E+04	6.1555E-03	8.3512E-03
1.257	1.4437E-03	9.3116E-01	1.3393E+02	-8.6250E-01	2.2897E+01	4.3906E+00	1.4520E+02	6.0726E-03	6.0202E-03
1.676	3.9677E-03	9.3721E-01	2.7711E+01	1.1522E+00	3.5773E+01	4.9103E+00	4.7105E+01	1.1457E-02	1.2513E-02
2.094	7.1711E-03	9.5182E-01	1.0293E+01	3.3415E-01	8.1922E+01	6.1206E+00	1.6374E+00	2.2608E-02	2.7594E-02
2.513	1.0521E-02	9.2061E-01	4.2244E+00	2.2040E-01	1.4336E+02	6.6752E+00	2.3284E+00	3.4211E-02	4.7838E-02
2.932	1.0843E-02	7.4658E-01	2.8736E+00	7.4426E-02	2.4014E+02	8.2149E+00	5.5197E-01	5.2584E-02	8.9935E-02
3.351	9.9214E-03	7.6341E-01	2.9750E+00	8.0863E-02	4.7440E+02	1.8036E+01	1.6748E+00	9.2535E-02	2.1600E-01
3.770	8.4426E-03	6.3869E-01	2.5806E+00	1.8989E-01	7.0207E+02	4.2839E+01	2.2090E+00	1.1590E-01	3.8810E-01
4.189	7.5554E-03	4.5569E-01	1.9953E+00	5.3385E-01	1.0047E+03	6.9141E+01	3.6329E+00	1.2277E-01	7.8316E-01
4.608	5.6335E-03	3.4966E-01	1.5686E+00	1.0349E+00	1.4490E+03	9.7830E+01	2.7274E+00	1.3813E-01	1.4772E+00
5.027	3.3632E-03	2.3329E-01	1.4062E+00	1.2481E+00	1.3979E+03	1.3612E+02	2.6027E+00	1.1567E-01	1.7527E+00
5.445	3.5786E-03	6.7808E-02	1.0779E+00	9.9624E-01	7.5043E+02	1.2833E+02	2.2193E+00	4.7417E-02	1.1970E+00
5.864	4.0823E-03	2.6476E-02	7.4615E-01	4.6466E-01	3.3157E+02	9.0027E+01	1.3056E+00	2.8356E-02	6.3179E-01
6.283	3.0937E-03	2.5729E-02	7.9735E-01	3.1578E-01	1.2787E+02	9.2756E+01	6.5385E-01	3.7656E-02	3.5297E-01
6.702	1.5134E-03	2.8263E-02	1.1268E+00	1.5150E-01	3.6420E+01	1.4747E+02	1.0366E+00	4.4220E-02	2.2803E-01
7.121	7.9877E-04	1.6959E-02	1.5265E+00	1.9350E-01	2.3200E+01	2.2138E+02	5.8823E-01	2.5664E-02	1.5034E-01
7.540	4.7733E-04	2.0124E-02	2.2127E+00	3.7907E-01	1.0404E+01	2.0947E+02	6.7118E-01	3.3870E-02	1.1683E-01
7.959	3.5217E-04	2.8109E-02	2.8621E+00	6.1475E-01	7.9221E+00	1.2321E+02	-9.3717E-02	5.5548E-02	1.2456E-01
8.378	3.6832E-04	2.2218E-02	2.3241E+00	5.4141E-01	2.1959E+00	6.7070E+01	4.0068E-01	3.6537E-02	7.6010E-02
8.796	3.0837E-04	2.2999E-02	2.7113E+00	5.7692E-01	2.9554E+00	3.2499E+01	4.7916E-02	2.0665E-02	4.9836E-02
9.215	2.3837E-04	3.2247E-02	4.3636E+00	7.4748E-01	7.4496E-01	1.9999E+01	7.6418E-01	2.1233E-02	3.3415E-02
9.634	1.6748E-04	2.8119E-02	4.6612E+00	5.5492E-01	4.8311E-01	4.1178E+01	2.9419E-01	1.9470E-02	2.5385E-02

Figure 14 - Sheet g

RESPONSE AMPLITUDE OPERATORS

5 PERCENT AMPLITUDE RANGES

FREQ. RANGE	WINGAC	PITCRT	ROLLRT	YAW RT	HEAVAC	CABNAC	WINGAC
1	2.09- 8.80	2.51- 6.28	2.51- 8.38	2.93- 7.54	1.26- 5.03	1.26- 5.86	1.26- 6.28
2	9.63- 9.63	0.00- 0.00	0.00- 0.00	0.00- 0.00	.10- 0.00	.07- .00	.06- 0.00
OMEGAE	WINGAC / WAVEHT	PITCRT / WAVEHT	ROLLRT / WAVEHT	YAW RT / WAVEHT	HEAVAC / WAVEHT	CABNAC / WAVEHT	WINGAC / WAVEHT
.419	9.9700E-03	4.6782E+01	5.2855E+00	1.5073E+04	2.9373E+02	4.4904E+02	3.3524E+02
.838	7.2978E-03	3.2795E+01	8.8541E+00	4.7372E+03	1.2936E+01	1.7556E+01	1.5337E+01
1.257	6.1319E-03	6.3427E+01	4.3591E+00	2.7565E+02	2.5209E+00	2.4991E+00	2.5454E+00
1.676	1.1958E-02	1.3210E+02	5.4134E+00	5.6681E+01	1.5048E+00	1.6435E+00	1.5706E+00
2.094	2.6612E-02	4.6546E+02	8.8148E+00	1.4438E+01	1.2163E+00	1.4840E+00	1.4317E+00
2.513	3.8105E-02	1.0478E+03	1.4875E+01	6.6511E+00	8.8759E-01	1.2411E+00	9.9096E-01
2.932	5.4871E-02	2.2315E+03	2.0256E+01	6.0673E+00	7.3640E-01	1.2595E+00	7.6344E-01
3.351	1.1131E-01	5.7280E+03	6.4302E+01	1.0209E+01	7.5938E-01	1.7732E+00	9.1866E-01
3.770	1.4310E-01	1.0247E+04	1.7667E+02	2.3587E+01	5.9398E-01	1.9890E+00	7.6414E-01
4.189	1.5243E-01	1.8291E+04	2.4590E+02	2.9408E+01	4.1290E-01	2.6333E+00	5.1254E-01
4.608	2.3356E-01	3.0676E+04	3.5147E+02	2.8491E+01	3.1723E-01	3.3924E+00	5.3639E-01
5.027	3.6541E-01	3.3166E+04	6.8843E+02	4.7238E+01	1.8756E-01	2.8420E+00	5.9253E-01
5.445	3.4220E-01	2.1091E+04	8.1051E+02	5.0493E+01	5.5823E-02	1.4092E+00	4.0287E-01
5.864	2.5503E-01	1.0500E+04	6.1691E+02	2.6475E+01	2.4556E-02	5.5299E-01	2.2322E-01
6.283	2.9386E-01	4.5123E+03	7.0658E+02	2.1647E+01	2.5011E-02	2.3437E-01	1.9518E-01
6.702	5.6029E-01	1.5922E+03	1.2693E+03	3.0395E+01	2.2688E-02	1.1700E-01	2.8747E-01
7.121	1.0213E+00	1.1213E+03	2.0840E+03	3.2253E+01	1.0332E-02	6.0405E-02	4.1117E-01
7.540	1.2061E+00	5.9172E+02	2.1231E+03	2.4733E+01	1.0849E-02	3.7423E-02	3.8633E-01
7.959	1.0036E+00	4.6103E+02	1.4115E+03	1.9466E+01	1.4332E-02	3.2138E-02	2.5894E-01
8.378	6.5599E-01	2.4905E+02	8.6221E+02	1.1291E+01	7.6793E-03	1.5974E-02	1.3786E-01
8.796	3.4874E-01	2.3381E+02	4.3521E+02	6.9304E+00	3.5729E-03	8.6163E-03	6.0295E-02
9.215	3.2387E-01	1.6973E+02	2.8930E+02	9.4767E+00	3.0477E-03	4.7963E-03	4.6057E-02
9.634	6.4277E-01	1.4054E+02	5.8442E+02	1.0753E+01	2.3405E-03	3.0532E-03	7.7233E-02

Figure 14 - Sheet h

NONDIMENSIONAL TRANSFER FUNCTIONS

5 PERCENT AMPLITUDE RANGES

		WAVEHT	HEAVE	SWAY	SURGE	PITCH	ROLL	YAW	HEAVAC	CABNAC
FREQ. RANGE	1	1.26- 7.12	1.26- 5.03	8.90- 9.63	1.68- 5.28	2.09- 5.86	2.09- 7.96	2.09- 6.73	2.09- 6.70	2.51- 6.28
	2	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00	0.00- 0.00

L/LAM	OMEGAE	WAVEHT SPECTRUM	HEAVE / WAVEHT	SWAY / WAVEHT	SURGE / WAVEHT	PITCH / WSLOPE	ROLL / WSLOPE	YAW / WSLOPE	HEAVAC / WAVEHT	CABNAC / WAVEHT
.01	.419	1.5821E-04	3.2926E-01	9.3607E+01	5.6724E+01	3.1323E+01	2.1874E+01	1.3103E+03	1.6858E+01	2.1290E+01
.03	.838	2.9137E-04	7.2391E-01	4.1950E+01	1.4921E+01	4.3972E+00	2.7829E+00	1.3520E+02	3.5996E+00	4.1927E+00
.06	1.257	1.4437E-03	9.1169E-01	1.1568E+01	9.2971E-01	1.7029E+00	7.4572E-01	4.2984E+00	1.5990E+00	1.5821E+00
.10	1.676	3.9677E-03	9.6809E-01	5.2641E+00	1.0734E+00	1.1973E+00	4.4360E-01	1.3740E+00	1.2277E+00	1.2830E+00
.16	2.094	7.1711E-03	9.7561E-01	3.2082E+00	5.7905E-01	1.1596E+00	3.1697E-01	1.6395E-01	1.1038E+00	1.2192E+00
.23	2.513	1.0521E-02	9.0598E-01	2.0553E+00	4.6946E-01	1.0653E+00	2.2997E-01	1.3576E-01	9.4298E-01	1.1150E+00
.31	2.932	1.0843E-02	8.6405E-01	1.6952E+00	2.7281E-01	1.0133E+00	1.8735E-01	4.8664E-02	8.5983E-01	1.1232E+00
.41	3.351	3.9914E-03	8.7373E-01	1.7248E+00	2.8436E-01	1.0931E+00	2.1254E-01	6.4767E-02	8.7213E-01	1.3327E+00
.52	3.770	9.4426E-03	7.0918E-01	1.6064E+00	4.3577E-01	1.0478E+00	2.5992E-01	5.8771E-02	7.7132E-01	1.4114E+00
.64	4.189	7.5554E-03	6.7505E-01	1.4090E+00	7.3065E-01	1.0150E+00	2.6633E-01	6.1050E-02	6.4301E-01	1.6241E+00
.77	4.608	5.6339E-03	5.9132E-01	1.2524E+00	1.0173E+00	1.0073E+00	2.6192E-01	4.3717E-02	5.6368E-01	1.8433E+00
.92	5.027	3.9632E-03	4.8300E-01	1.1858E+00	1.1172E+00	8.3162E-01	2.5951E-01	3.5884E-02	4.3343E-01	1.6872E+00
1.08	5.445	3.5748E-03	2.6040E-01	1.0382E+00	9.4670E-01	5.1919E-01	2.1520E-01	2.8234E-02	2.3646E-01	1.1981E+00
1.25	5.864	4.0523E-03	1.5962E-01	8.6390E-01	6.8191E-01	2.9757E-01	1.5506E-01	1.8674E-02	1.5683E-01	7.4423E-01
1.44	6.283	3.0807E-03	1.6040E-01	8.9294E-01	4.6452E-01	1.6093E-01	1.3710E-01	1.1564E-02	1.5928E-01	4.9451E-01
1.64	6.702	1.5134E-03	1.6812E-01	1.0615E+00	3.8922E-01	7.5507E-02	1.5194E-01	1.2739E-02	1.5075E-01	3.4232E-01
1.95	7.121	7.8877E-04	1.3023E-01	1.2355E+00	4.3989E-01	5.3392E-02	1.6490E-01	8.5002E-03	1.0173E-01	2.4597E-01
2.07	7.540	4.7733E-04	1.4196E-01	1.4875E+00	6.1498E-01	3.1887E-02	1.4339E-01	8.0990E-03	1.0424E-01	1.9361E-01
2.31	7.959	3.5207E-04	1.6766E-01	1.6918E+00	7.8406E-01	2.4973E-02	9.3487E-02	2.7162E-03	1.1981E-01	1.7942E-01
2.56	8.378	3.6932E-04	1.4906E-01	1.5245E+00	7.3590E-01	1.1859E-02	6.5579E-02	5.0687E-03	8.7697E-02	1.2649E-01
2.82	8.796	3.0897E-04	1.5165E-01	1.6466E+00	7.5955E-01	1.2496E-02	4.1405E-02	1.5899E-03	5.9822E-02	9.2993E-02
3.10	9.215	2.0807E-04	1.7957E-01	2.0889E+00	9.6457E-01	5.7115E-03	2.9595E-02	5.7851E-03	5.5251E-02	6.9311E-02
3.39	9.634	1.6749E-04	1.6769E-01	2.1590E+00	7.4493E-01	4.2095E-03	3.8854E-02	3.2841E-03	4.8418E-02	5.5273E-02

Figure 14 - Sheet 1

NONDIMENSIONAL TRANSFER FUNCTIONS

5 PERCENT AMPLITUDE RANGES

		WINGAC	PITCRT	ROLLPT	YAW RT	HEAVAC	CARNAC	WINGAC
FREQ. RANGE	1	2.09- 8.80	2.51- 6.28	2.51- 9.39	2.93- 7.54	1.26- 5.03	1.26- 5.86	1.26- 6.28
	2	9.63- 9.63	0.00- 0.00	0.00- 0.00	0.00- 0.00	.10- 0.00	.07- .00	.06- 0.00
L/LAM	OMEGAE	WINGAC / WAVEHT	PITCRT / WSLOPE	ROLLPT / WSLOPE	YAW RT / WSLOPE	HEAVAC / WAVEHT	CARNAC / WAVEHT	WINGAC / WAVEHT
.01	.419	1.8324E+01	5.2020E+01	1.7580E+01	9.3479E+02	1.6844E+01	2.1191E+01	1.0109E+01
.03	.838	3.9194E+00	5.4737E+00	2.8441E+00	6.5747E+01	3.5967E+00	4.1893E+00	3.9162E+00
.06	1.257	1.5967E+00	2.2555E+00	5.9129E-01	4.7020E+00	1.5877E+00	1.5939E+00	1.5954E+00
.10	1.676	1.2543E+00	1.3732E+00	7.7799E-01	8.9951E-01	1.2257E+00	1.2820E+00	1.2532E+00
.16	2.094	1.1975E+00	1.3198E+00	1.8162E-01	2.3244E-01	1.1029E+00	1.2182E+00	1.1365E+00
.23	2.513	9.9627E-01	1.1459E+00	1.3654E-01	9.1298E-02	9.4217E-01	1.1141E+00	9.9547E-01
.31	2.932	8.7732E-01	1.0531E+00	1.0034E-01	5.4912E-02	8.5814E-01	1.1223E+00	8.7561E-01
.41	3.351	9.5924E-01	1.1303E+00	1.1976E-01	4.7718E-02	8.7142E-01	1.3316E+00	9.5847E-01
.52	3.770	8.7436E-01	1.0618E+00	1.3942E-01	5.0942E-02	7.7070E-01	1.4103E+00	8.7415E-01
.64	4.189	7.1653E-01	1.0342E+00	1.1988E-01	4.1466E-02	6.4249E-01	1.6228E+00	7.1592E-01
.77	4.608	7.3209E-01	1.0062E+00	1.0770E-01	3.0665E-02	5.6323E-01	1.8419E+00	7.3239E-01
.92	5.027	7.7038E-01	8.0588E-01	1.1611E-01	3.0414E-02	4.3309E-01	1.6858E+00	7.6976E-01
1.08	5.445	6.3523E-01	5.0546E-01	9.9087E-02	2.4732E-02	2.3627E-01	1.1871E+00	6.3472E-01
1.25	5.864	4.7294E-01	2.8554E-01	6.9326E-02	1.4338E-02	1.5670E-01	7.4363E-01	4.7246E-01
1.44	6.283	4.4214E-01	1.5219E-01	6.0225E-02	1.0541E-02	1.5815E-01	4.8412E-01	4.4179E-01
1.64	6.702	5.3659E-01	7.4492E-02	6.5511E-02	1.0292E-02	1.5062E-01	3.4205E-01	5.3616E-01
1.85	7.121	6.4174E-01	5.2118E-02	7.1051E-02	9.8390E-03	1.0165E-01	2.4577E-01	6.4123E-01
2.07	7.540	6.2206E-01	3.1894E-02	6.0413E-02	6.5206E-03	1.0416E-01	1.9345E-01	6.2155E-01
2.31	7.959	5.0927E-01	2.8937E-02	4.1893E-02	4.9196E-03	1.1972E-01	1.7927E-01	5.0886E-01
2.56	8.378	3.7159E-01	1.5084E-02	2.8066E-02	3.2118E-03	8.7626E-02	1.2639E-01	3.7129E-01
2.82	8.796	2.4575E-01	1.2625E-02	1.7225E-02	2.1736E-03	5.9774E-02	9.2824E-02	2.4555E-01
3.10	9.215	2.1478E-01	9.3558E-03	1.2215E-02	2.0928E-03	5.5206E-02	6.9255E-02	2.1461E-01
3.39	9.634	2.7813E-01	7.4504E-03	1.5193E-02	2.0608E-03	4.8379E-02	5.5228E-02	2.7791E-01

Figure 14 - Sheet j

RUNS 592 - 592 HEAD SEAS 0 KNOTS
SMALL DAMPING PLATES

STATISTICAL PROPERTIES
(COMPUTED FROM DOUBLE AMPLITUDE DISTRIBUTIONS)

CHANNEL	1	2	3	4	5	6	7	8	9
TITLE	WAVEHT	HEAVE	SWAY	SURGE	PITCH	ROLL	YAW	HEAVAC	CABNAC
UNIT	FEET	FEET	FEET	FEET	DEG	DEG	DEG	G	G
NO DB. AMPL.	144	118	21	24	161	190	14	156	183
NO DATA PTS.	1912	1912	1912	1912	1912	1912	1912	1912	1912
MEAN	1.9733E-03	-6.2759E-03	1.0454E+00	-3.9634E-01	2.5547E-01	-2.6051E-01	2.7660E-01	-1.0741E-03	-1.3913E-03
ROOTDD	1.9350E-01	1.4143E-01	1.1008E+00	6.6202E-01	4.1374E+00	1.3114E+00	4.7337E+00	4.8780E-02	1.2432E-01
AVERAGE	3.3194E-01	2.4203E-01	1.6667E+00	5.8333E-01	7.2117E+00	2.2935E+00	7.0000E+00	8.7179E-02	2.1467E-01
SIGNIFICANT	5.1412E-01	3.7400E-01	2.3257E+00	1.2300E+00	1.1129E+01	3.6820E+00	1.3400E+01	1.3582E-01	3.3467E-01
AVE.HIGH.1/10	6.5619E-01	4.5648E-01	2.4900E+00	1.8667E+00	1.4036E+01	4.9589E+00	1.5000E+01	1.6953E-01	4.2765E-01
MEDIAN	3.0832E-01	2.2620E-01	2.0200E+00	3.6923E-01	6.7561E+00	2.0750E+00	7.0000E+00	8.6429E-02	2.0471E-01
MODE	2.7200E-01	2.0421E-01	2.1750E+00	3.1111E-01	6.1818E+00	1.8833E+00	1.0000E+00	8.8000E-02	1.9765E-01
MAX DB. AMPL.	8.0335E-01	5.3419E-01	2.4312E+00	2.2554E+00	1.9278E+01	6.6411E+00	1.5431E+01	2.2081E-01	5.7193E-01
MIN DB. AMPL.	2.8919E-02	3.8251E-02	3.8210E-01	9.3389E-02	1.4845E+00	2.0753E-01	2.7589E-01	3.6623E-03	1.2208E-03
MAX DATA PTS.	5.0110E-01	3.2113E-01	2.0938E+00	1.3915E+00	1.0695E+01	3.9270E+00	8.5299E+00	1.1644E-01	2.8396E-01
MIN DATA PTS.	-4.4123E-01	-2.9118E-01	-9.3923E-01	-9.7387E-01	-9.6944E+00	-3.8750E+00	-8.2166E+00	-1.2161E-01	-2.8797E-01

CHANNEL	10	11	12	13
TITLE	WINGAC	PITCRT	ROLLRT	YAW RT
UNIT	G	RAD/SEC	RAD/SEC	RAD/SEC
NO DB. AMPL.	197	170	222	87
NO DATA PTS.	1912	1912	1912	1912
MEAN	-5.1161E-03	1.0740E+00	4.4275E-02	3.5942E-02
ROOTDD	7.7363E-02	1.7790E+01	3.1018E+00	1.7369E+00
AVERAGE	1.3566E-01	3.1706E+01	5.0360E+00	1.8437E+00
SIGNIFICANT	2.1561E-01	4.9845E+01	8.9192E+00	3.1650E+00
AVE.HIGH.1/10	2.9125E-01	6.4265E+01	1.3231E+01	4.5566E+00
MEDIAN	1.2591E-01	2.9200E+01	4.2400E+00	1.5975E+00
MODE	9.6154E-02	2.6333E+01	3.2787E+00	1.4154E+00
MAX DB. AMPL.	4.1567E-01	8.8562E+01	1.7524E+01	6.1478E+00
MIN DB. AMPL.	5.4935E-03	2.4208E+00	3.9197E-01	1.0498E-01
MAX DATA PTS.	2.5720E-01	4.4529E+01	9.9721E+00	3.8681E+00
MIN DATA PTS.	-1.8654E-01	-4.4733E+01	-1.1573E+01	-5.5660E+00

Figure 14 - Sheet k

DOUBLE AMPLITUDES				DATA POINTS	
FREQUENCY DISTRIBUTION		CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION	
WAVEHT	NO OF OCC	LESS THAN	MORE THAN	WAVEHT	NO OF OCC
0. FEET	5	0	144	-4.8E-01 FEET	2
1.0E-01 FEET	23	5	139	-4.0E-01 FEET	11
2.0E-01 FEET	41	28	116	-3.2E-01 FEET	31
3.0E-01 FEET	34	69	75	-2.4E-01 FEET	195
4.0E-01 FEET	19	103	41	-1.6E-01 FEET	227
5.0E-01 FEET	15	122	22	-8.0E-02 FEET	516
6.0E-01 FEET	3	137	7	1.3E-15 FEET	467
7.0E-01 FEET	2	140	4	8.0E-02 FEET	236
8.0E-01 FEET	2	142	2	1.6E-01 FEET	176
9.0E-01 FEET		144	0	2.4E-01 FEET	33
				3.2E-01 FEET	19
				4.0E-01 FEET	5
				4.8E-01 FEET	3
				5.6E-01 FEET	

DOUBLE AMPLITUDES				DATA POINTS	
FREQUENCY DISTRIBUTION		CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION	
HEAVE	NO OF OCC	LESS THAN	MORE THAN	HEAVE	NO OF OCC
0. FEET	7	0	118	-3.0E-01 FEET	8
8.0E-02 FEET	19	7	111	-2.5E-01 FEET	26
1.6E-01 FEET	40	26	92	-2.0E-01 FEET	161
2.4E-01 FEET	23	66	52	-1.5E-01 FEET	139
3.2E-01 FEET	18	89	29	-1.0E-01 FEET	347
4.0E-01 FEET	8	107	11	-5.0E-02 FEET	287
4.8E-01 FEET	3	115	3	8.9E-16 FEET	448
5.6E-01 FEET		118	0	5.0E-02 FEET	225
				1.0E-01 FEET	217
				1.5E-01 FEET	72
				2.0E-01 FEET	36
				2.5E-01 FEET	4
				3.0E-01 FEET	2
				3.5E-01 FEET	

DOUBLE AMPLITUDES				DATA POINTS	
FREQUENCY DISTRIBUTION		CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION	
SWAY	NO OF OCC	LESS THAN	MORE THAN	SWAY	NO OF OCC
0. FEET	1	0	21	-1.2E+00 FEET	4
4.0E-01 FEET	4	1	20	-8.0E-01 FEET	585
8.0E-01 FEET	1	5	16	-4.0E-01 FEET	813
1.2E+00 FEET	1	6	15	5.3E-15 FEET	74
1.6E+00 FEET	3	7	14	4.0E-01 FEET	75
2.0E+00 FEET	10	10	11	8.0E-01 FEET	73
2.4E+00 FEET	1	20	1	1.2E+00 FEET	145
2.8E+00 FEET		21	0	1.6E+00 FEET	123
				2.0E+00 FEET	19
				2.4E+00 FEET	

DOUBLE AMPLITUDES				DATA POINTS	
FREQUENCY DISTRIBUTION		CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION	
SURGE	NO OF OCC	LESS THAN	MORE THAN	SURGE	NO OF OCC
0. FEET	13	0	24	-1.0E+00 FEET	20
4.0E-01 FEET	5	13	11	-8.0E-01 FEET	92
8.0E-01 FEET	2	18	6	-6.0E-01 FEET	268
1.2E+00 FEET	3	20	4	-4.0E-01 FEET	392
1.6E+00 FEET	0	23	1	-2.0E-01 FEET	341
2.0E+00 FEET	1	23	1	9.8E-15 FEET	199
2.4E+00 FEET		24	0	2.0E-01 FEET	216
				4.0E-01 FEET	178
				6.0E-01 FEET	69
				8.0E-01 FEET	57
				1.0E+00 FEET	63
				1.2E+00 FEET	17
				1.4E+00 FEET	

Figure 14 - Sheet 1

DOUBLE AMPLITUDES									DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
PITCH		NO OF OCC	LESS THAN	MORE THAN	PITCH		NO OF OCC
0.	DEG	4	0	161	-1.0E+01	DEG	5
2.0E+00	DEG	22	4	157	-8.0E+00	DEG	24
4.0E+00	DEG	33	26	135	-6.0E+00	DEG	103
6.0E+00	DEG	41	65	96	-4.0E+00	DEG	315
8.0E+00	DEG	21	106	55	-2.0E+00	DEG	482
1.0E+01	DEG	21	127	34	0.	DEG	491
1.2E+01	DEG	6	148	13	2.0E+00	DEG	343
1.4E+01	DEG	5	154	7	4.0E+00	DEG	123
1.6E+01	DEG	1	159	2	6.0E+00	DEG	42
1.8E+01	DEG	1	160	1	8.0E+00	DEG	3
2.0E+01	DEG		161	0	1.0E+01	DEG	1
					1.2E+01	DEG	

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
ROLL		NO OF OCC	LESS THAN	MORE THAN	ROLL		NO OF OCC
0.	DEG	10	0	190	-4.0E+00	DEG	5
8.0E-01	DEG	47	10	180	-3.2E+00	DEG	22
1.6E+00	DEG	64	57	133	-2.4E+00	DEG	59
2.4E+00	DEG	33	121	69	-1.6E+00	DEG	205
3.2E+00	DEG	20	154	36	-8.0E-01	DEG	590
4.0E+00	DEG	5	174	16	3.9E-14	DEG	602
4.8E+00	DEG	8	179	11	8.0E-01	DEG	269
5.6E+00	DEG	2	187	3	1.6E+00	DEG	61
6.4E+00	DEG	1	189	1	2.4E+00	DEG	10
7.2E+00	DEG		190	0	3.2E+00	DEG	3
					4.0E+00	DEG	

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
YAW		NO OF OCC	LESS THAN	MORE THAN	YAW		NO OF OCC
0.	DEG	6	0	14	-8.0E+00	DEG	72
2.0E+00	DEG	0	6	8	-6.0E+00	DEG	159
4.0E+00	DEG	0	6	8	-4.0E+00	DEG	256
6.0E+00	DEG	2	6	[illegible]	-2.0E+00	DEG	423
8.0E+00	DEG	0	8	6	0.	DEG	396
1.0E+01	DEG	1	8	6	2.0E+00	DEG	252
1.2E+01	DEG	4	9	5	4.0E+00	DEG	133
1.4E+01	DEG	1	13	1	6.0E+00	DEG	95
1.6E+01	DEG		14	0	8.0E+00	DEG	25
					1.0E+01	DEG	

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
HEAVAC		NO OF OCC	LESS THAN	MORE THAN	HEAVAC		NO OF OCC
0.	G	21	0	156	-1.2E-01	G	4
4.0E-02	G	48	21	135	-1.0E-01	G	10
8.0E-02	G	56	69	87	-8.0E-02	G	78
1.2E-01	G	24	125	31	-6.0E-02	G	130
1.6E-01	G	5	149	7	-4.0E-02	G	350
2.0E-01	G	2	154	2	-2.0E-02	G	319
2.4E-01	G		156	0	3.3E-16	G	468
					2.0E-02	G	270
					4.0E-02	G	226
					6.0E-02	G	44
					8.0E-02	G	11
					1.0E-01	G	2
					1.2E-01	G	

Figure 14 - Sheet m

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
CARNAC		NO OF OCC	LESS THAN	MORE THAN	CARNAC		NO OF OCC
0.	G	16	0	180	-3.0E-01	G	5
8.0E-02	G	36	16	164	-2.5E-01	G	26
1.6E-01	G	68	52	128	-2.0E-01	G	39
2.4E-01	G	32	120	60	-1.5E-01	G	195
3.2E-01	G	18	152	28	-1.0E-01	G	230
4.0E-01	G	8	170	10	-5.0E-02	G	446
4.8E-01	G	1	178	2	8.9E-16	G	465
5.6E-01	G	1	179	1	5.0E-02	G	236
6.4E-01	G		180	0	1.0E-01	G	197
					1.5E-01	G	65
					2.0E-01	G	14
					2.5E-01	G	4
					3.0E-01	G	

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
WINGAC		NO OF OCC	LESS THAN	MORE THAN	WINGAC		NO OF OCC
0.	G	11	0	197	-2.0E-01	G	2
5.0E-02	G	59	11	186	-1.6E-01	G	12
1.0E-01	G	55	70	127	-1.2E-01	G	94
1.5E-01	G	46	125	72	-8.0E-02	G	371
2.0E-01	G	12	171	26	-4.0E-02	G	897
2.5E-01	G	7	183	14	6.7E-16	G	399
3.0E-01	G	4	190	7	4.0E-02	G	333
3.5E-01	G	2	194	3	8.0E-02	G	139
4.0E-01	G	1	196	1	1.2E-01	G	22
4.5E-01	G		197	0	1.6E-01	G	8
					2.0E-01	G	4
					2.4E-01	G	1
					2.8E-01	G	

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
PITCRT		NO OF OCC	LESS THAN	MORE THAN	PITCRT		NO OF OCC
0.	RPS	8	0	170	-4.8E+01	RPS	2
1.0E+01	RPS	31	8	162	-4.0E+01	RPS	9
2.0E+01	RPS	50	39	131	-3.2E+01	RPS	54
3.0E+01	RPS	39	89	81	-2.4E+01	RPS	79
4.0E+01	RPS	18	128	42	-1.6E+01	RPS	329
5.0E+01	RPS	14	146	24	-8.0E+00	RPS	504
6.0E+01	RPS	7	160	10	0.	RPS	495
7.0E+01	RPS	2	167	3	8.0E+00	RPS	224
8.0E+01	RPS	1	169	1	1.6E+01	RPS	153
9.0E+01	RPS		170	0	2.4E+01	RPS	51
					3.2E+01	RPS	7
					4.0E+01	RPS	3
					4.8E+01	RPS	

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
ROLLRT		NO OF OCC	LESS THAN	MORE THAN	ROLLRT		NO OF OCC
0.	RPS	33	0	222	-1.2E+01	RPS	1
2.0E+00	RPS	72	33	189	-1.0E+01	RPS	6
4.0E+00	RPS	50	105	117	-8.0E+00	RPS	12
6.0E+00	RPS	37	155	67	-6.0E+00	RPS	55
8.0E+00	RPS	13	192	30	-4.0E+00	RPS	143
1.0E+01	RPS	3	205	17	-2.0E+00	RPS	741
1.2E+01	RPS	4	208	14	0.	RPS	659
1.4E+01	RPS	6	212	10	2.0E+00	RPS	243
1.6E+01	RPS	4	218	4	4.0E+00	RPS	26
1.8E+01	RPS		222	0	6.0E+00	RPS	21
					8.0E+00	RPS	5
					1.0E+01	RPS	

Figure 14 - Sheet n

DOUBLE AMPLITUDES					DATA POINTS		
FREQUENCY DISTRIBUTION			CUMULATIVE DISTRIBUTIONS		FREQUENCY DISTRIBUTION		
YAW RT		NO OF OCC	LESS THAN	MORE THAN	YAW RT		NO OF OCC
0.	RPS	12	0	87	-5.6E+00	RPS	3
8.0E-01	RPS	32	12	75	-4.8E+00	RPS	2
1.6E+00	RPS	26	44	43	-4.0E+00	RPS	12
2.4E+00	RPS	5	70	17	-3.2E+00	RPS	57
3.2E+00	RPS	6	75	12	-2.4E+00	RPS	149
4.0E+00	RPS	4	81	6	-1.6E+00	RPS	172
4.8E+00	RPS	[illegible]	85	2	-8.0E-01	RPS	628
5.6E+00	RPS	2	85	2	6.8E-14	RPS	403
6.4E+00	RPS		87	0	8.0E-01	RPS	339
					1.6E+00	RPS	95
					2.4E+00	RPS	46
					3.2E+00	RPS	5
					4.0E+00	RPS	

Figure 14 - Sheet o

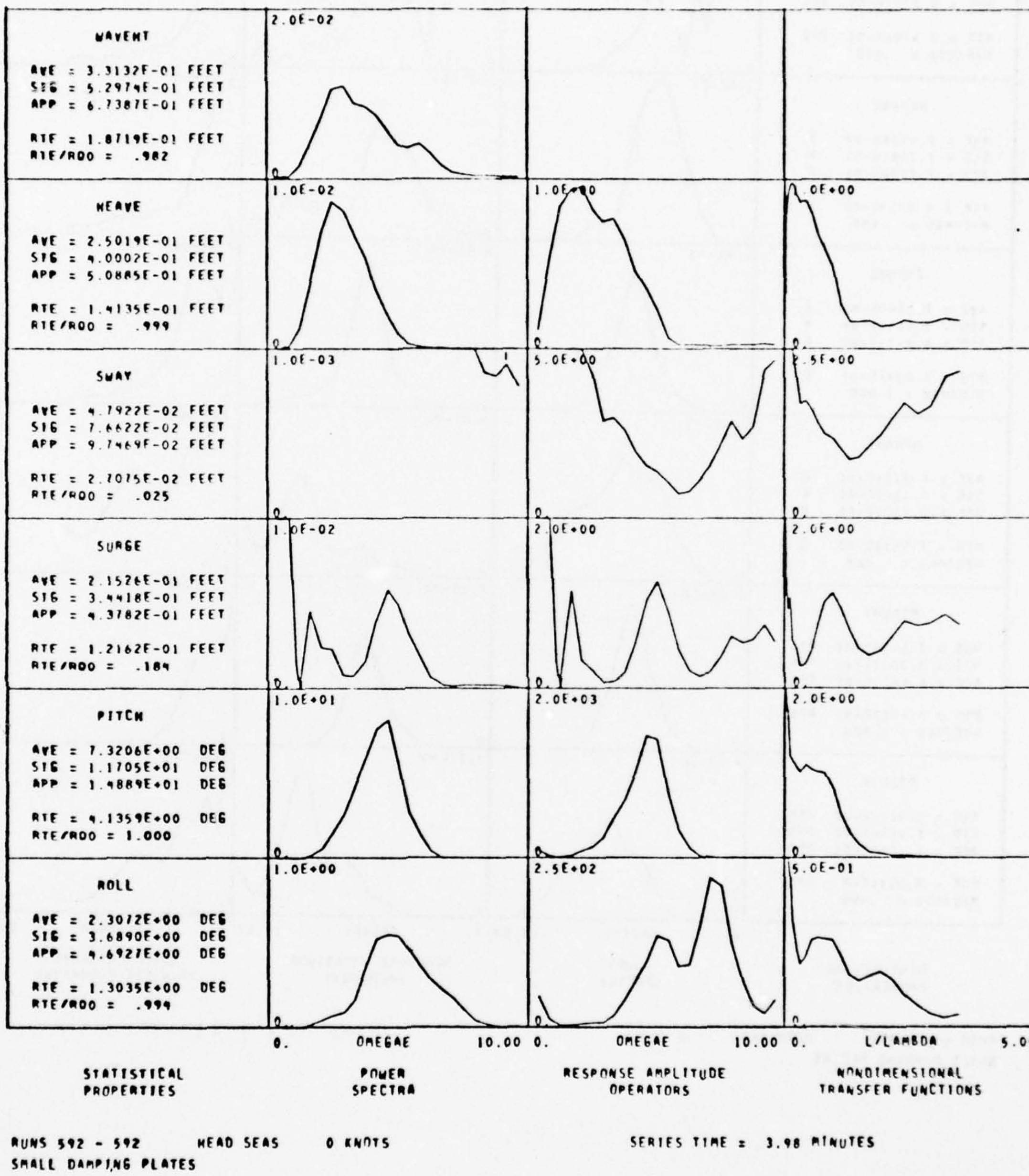


Figure 14 - Sheet p

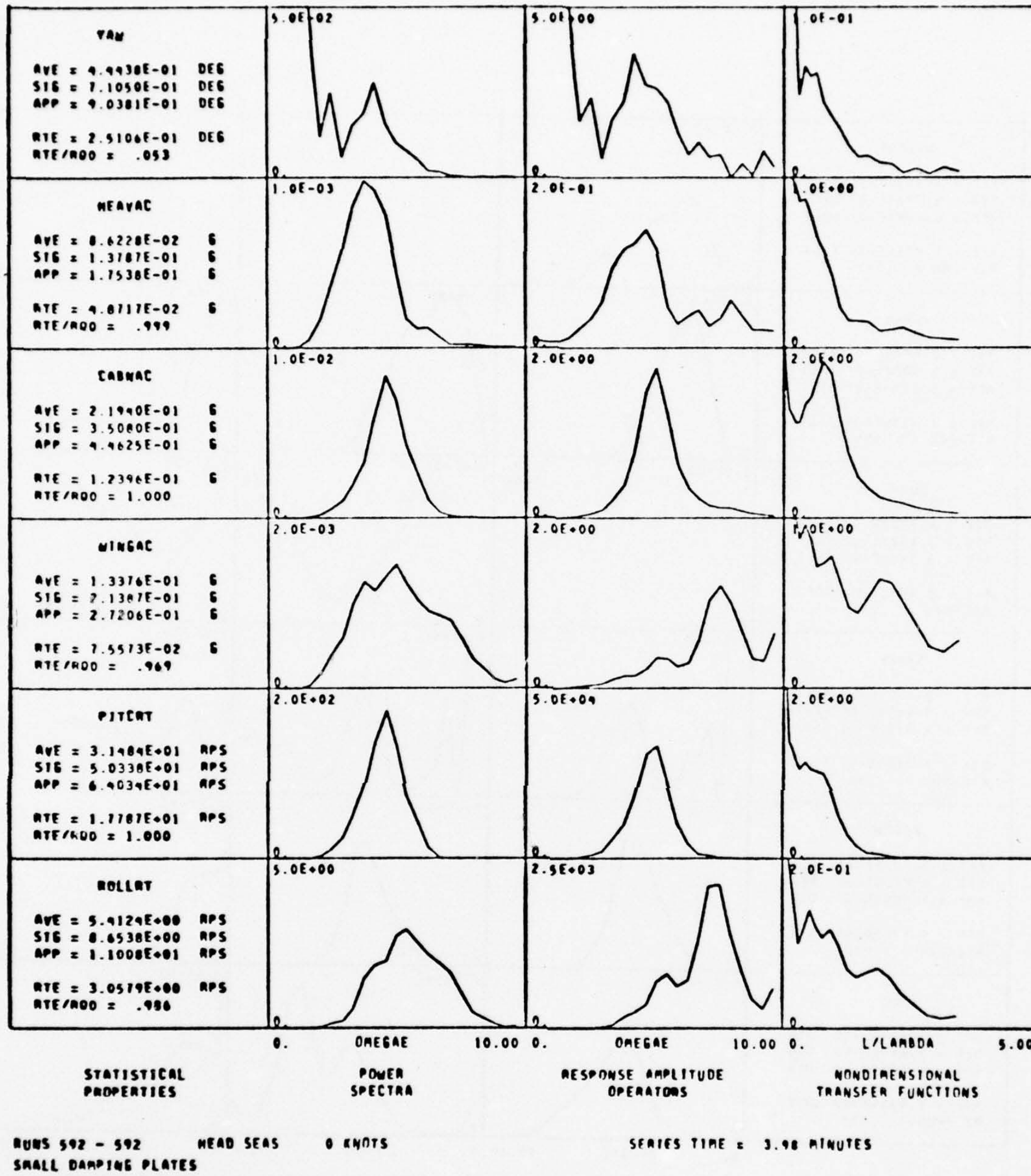


Figure 14 - Sheet q

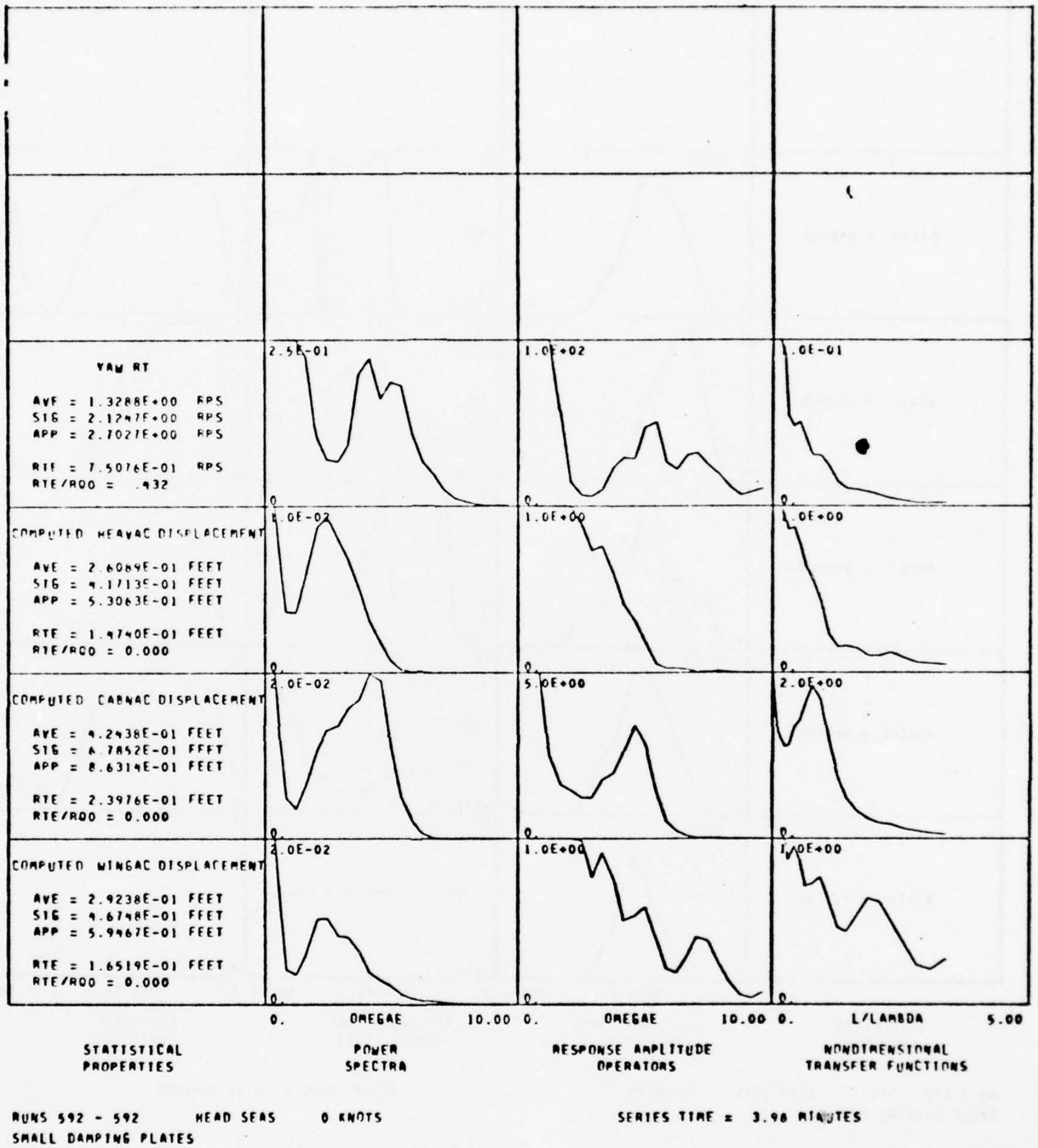


Figure 14 - Sheet r

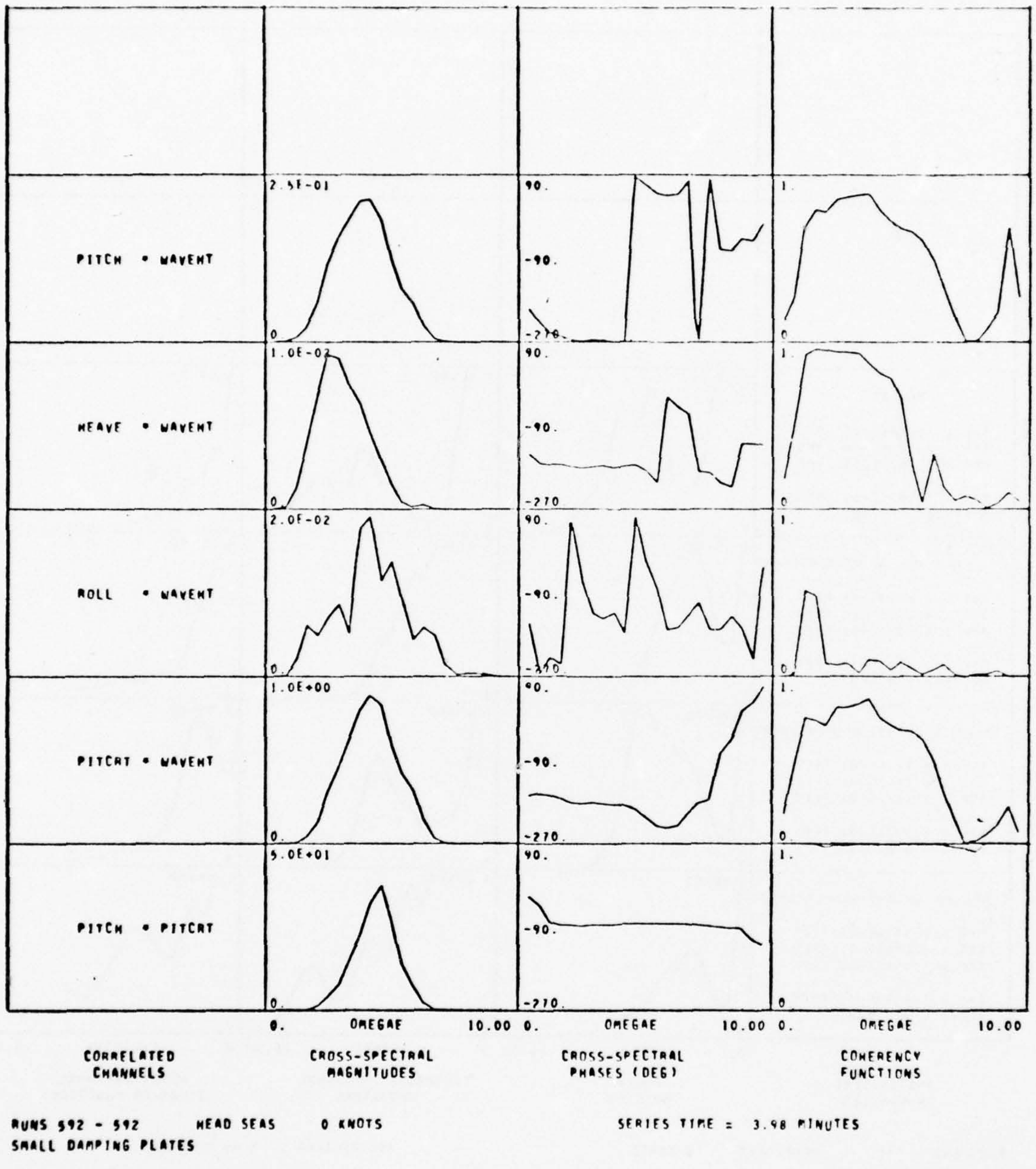


Figure 14 - Sheet s

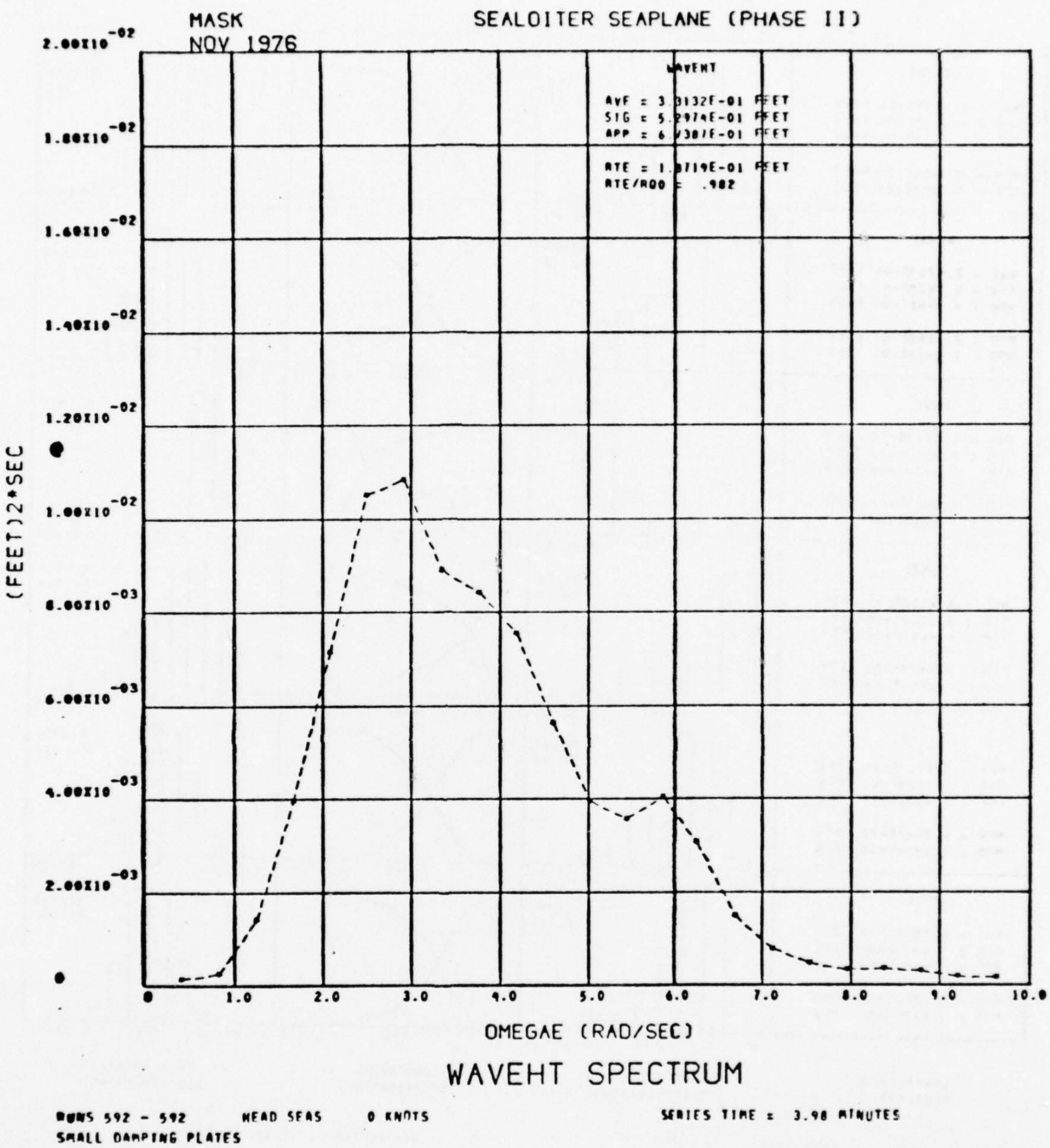


Figure 14 - Sheet t

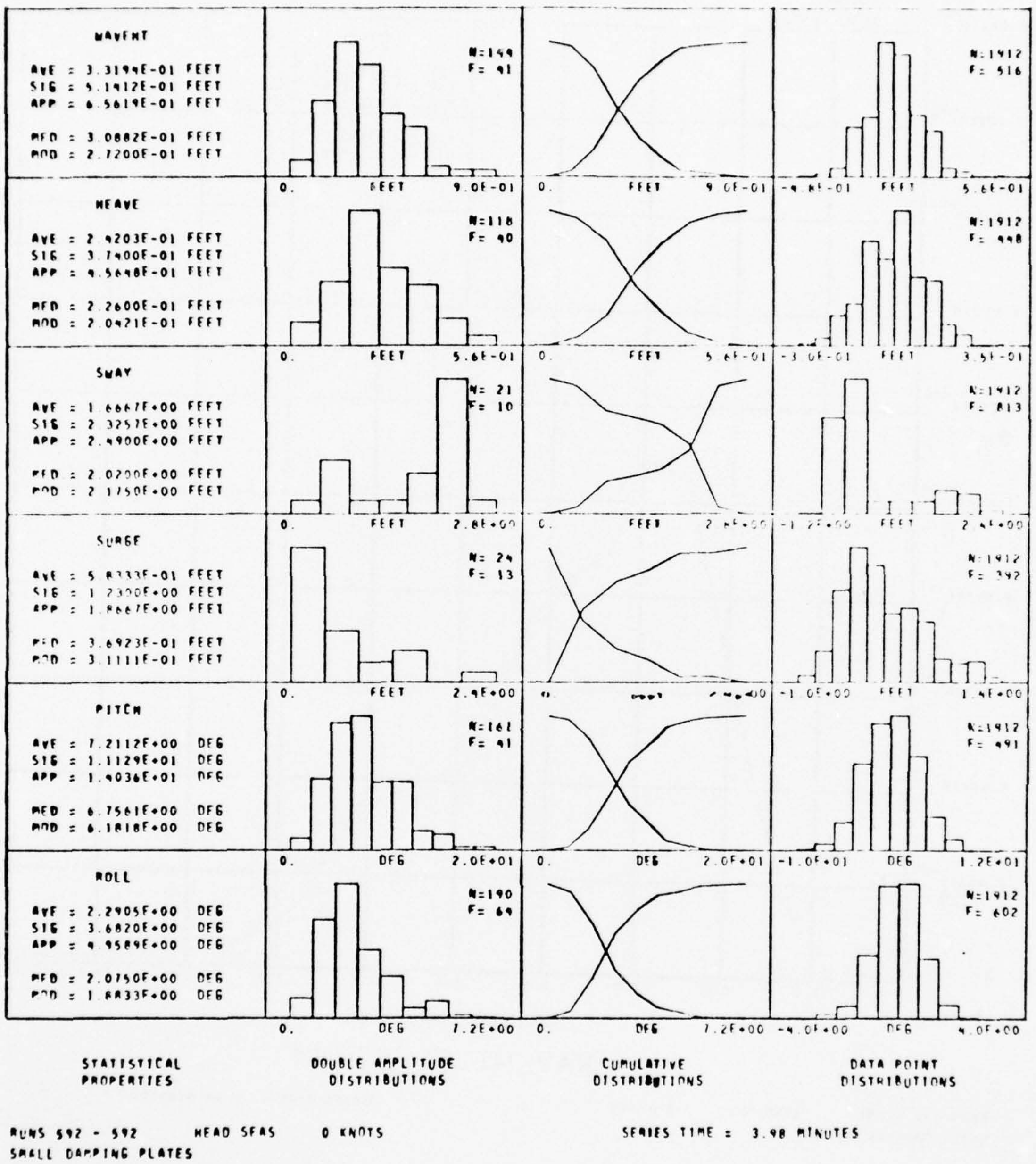
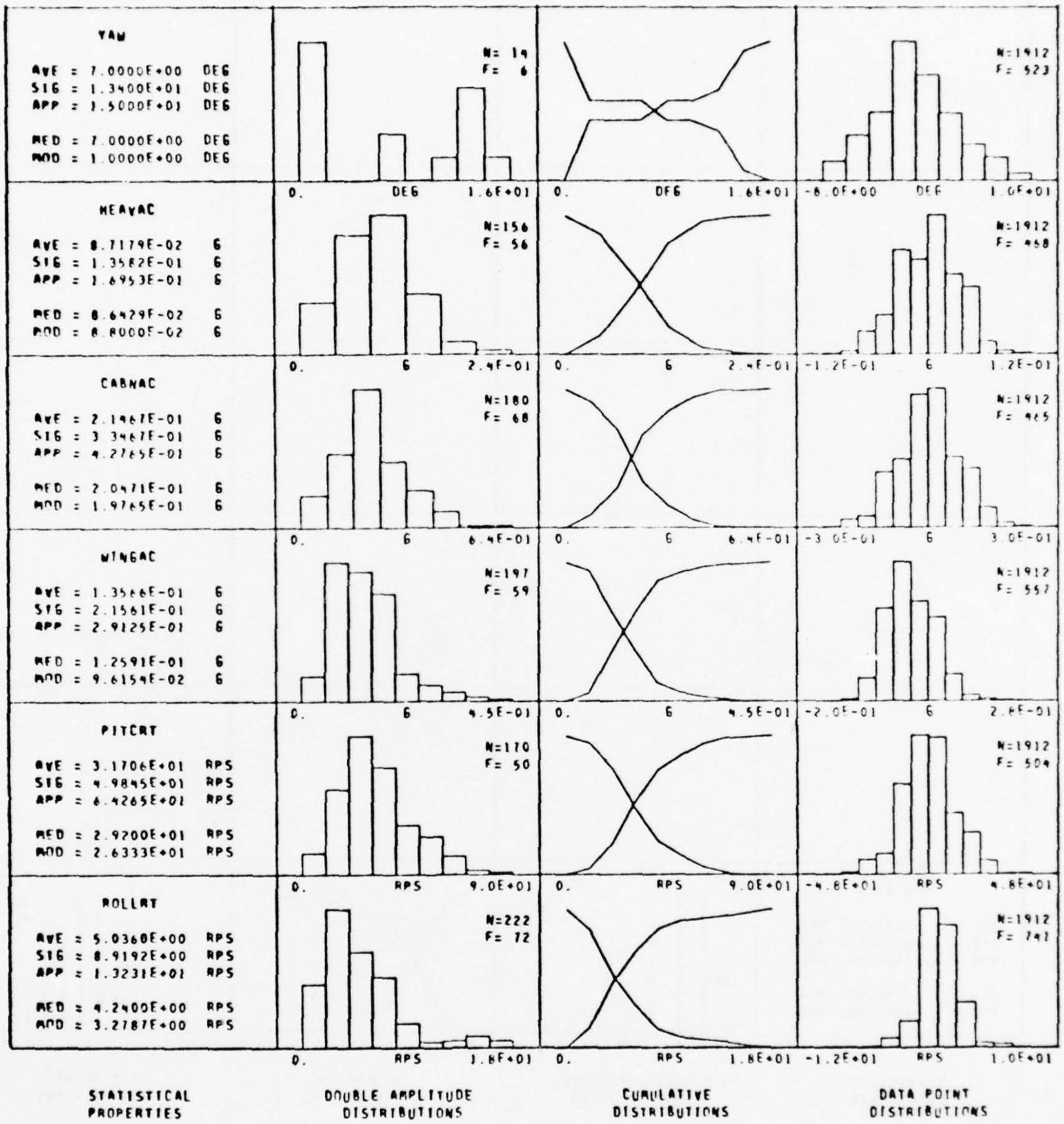


Figure 14 - Sheet u



RUNS 592 - 592 HEAD SEAS 0 KNOTS SERIES TIME = 3.98 MINUTES
SMALL DAMPING PLATES

Figure 14 - Sheet v

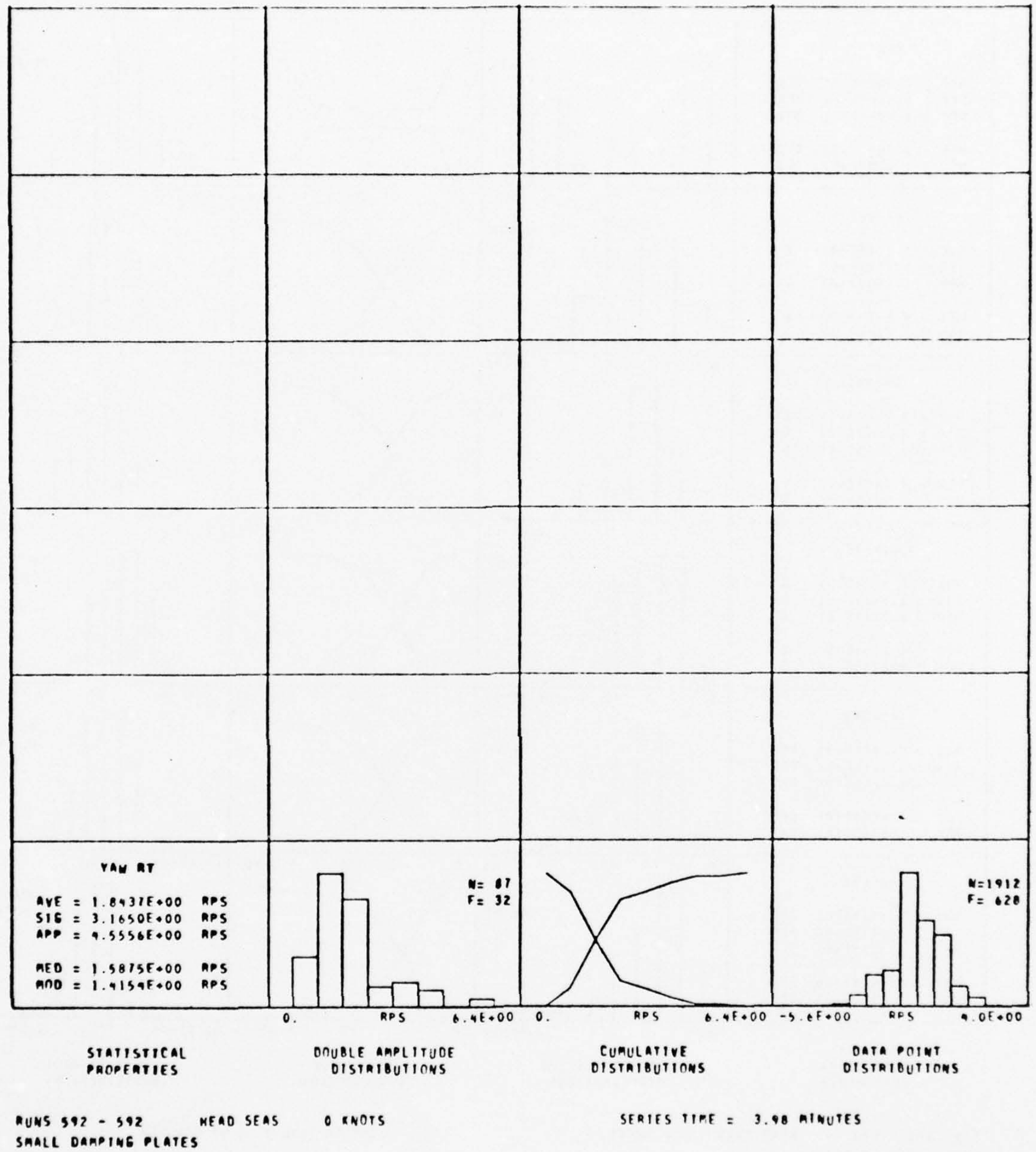


Figure 14 - Sheet w

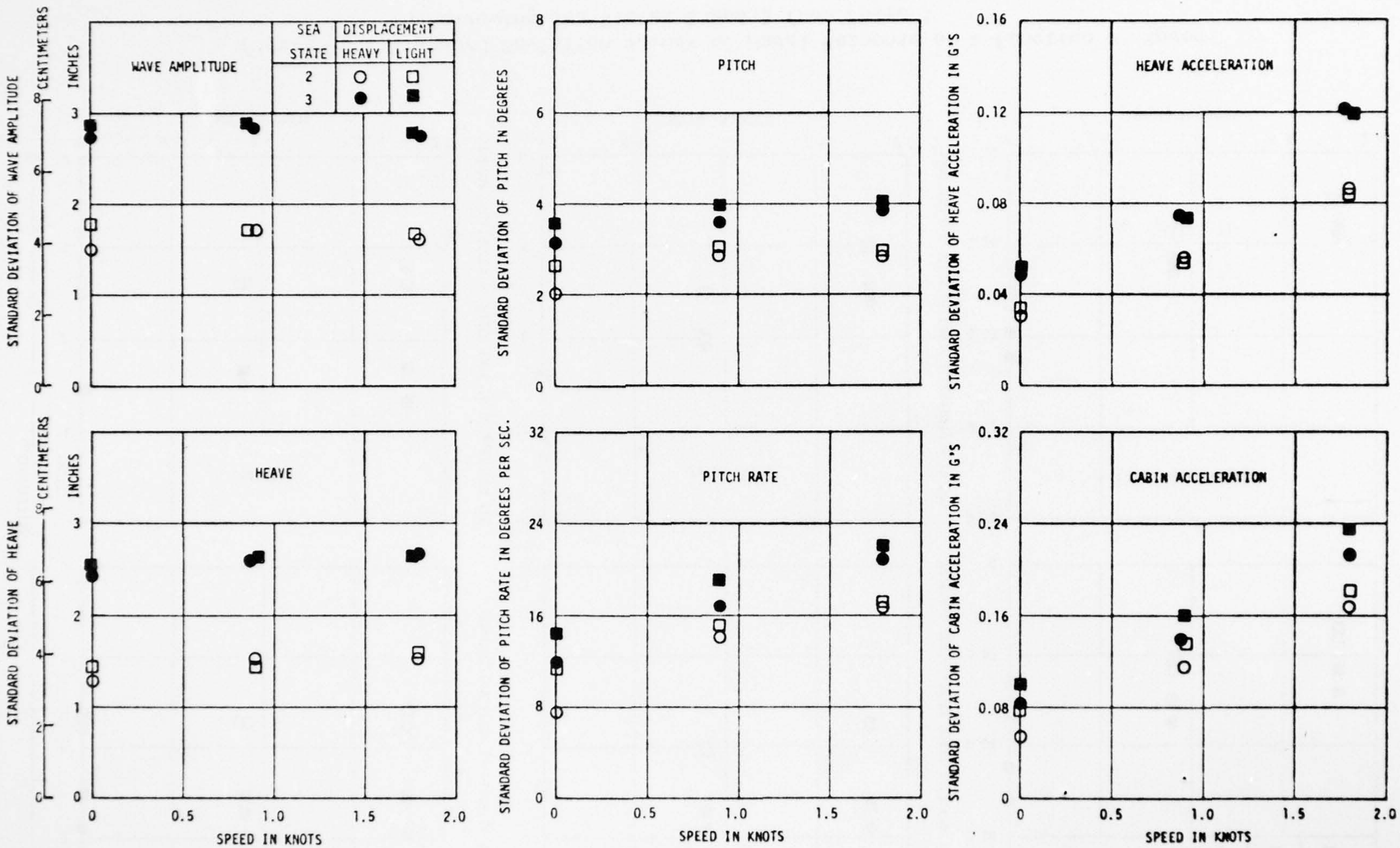


Figure 15 - Standard Deviation Values of Model Response as a Function of Speed in Head Sea States 2 and 3 from Phase 1

AD-A040 062   DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC   F/G 1/3
SEAKEEPING CHARACTERISTICS OF A PRELIMINARY DESIGN FOR A SEA LO--ETC(U)
FEB 77   A GERSTEN, J BONILLA-NORAT, L MURRAY

UNCLASSIFIED   SPD-748-02   NL

2 OF 2
AD
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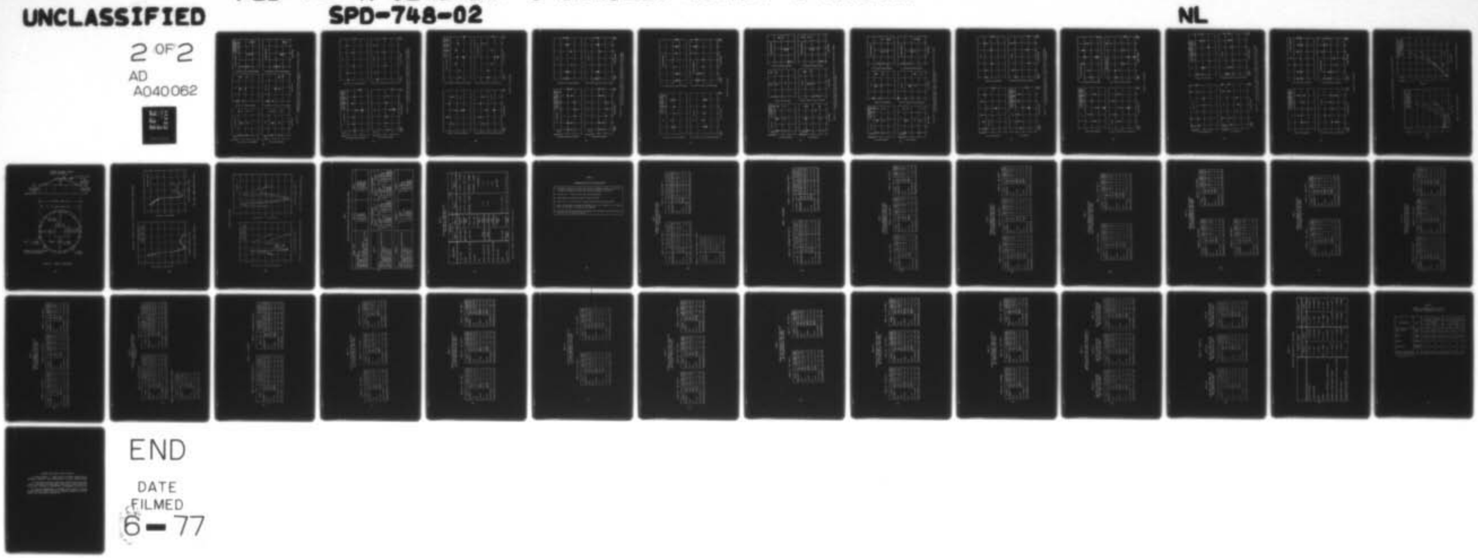

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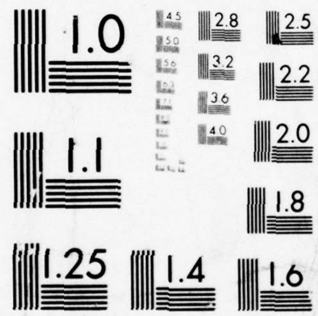

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

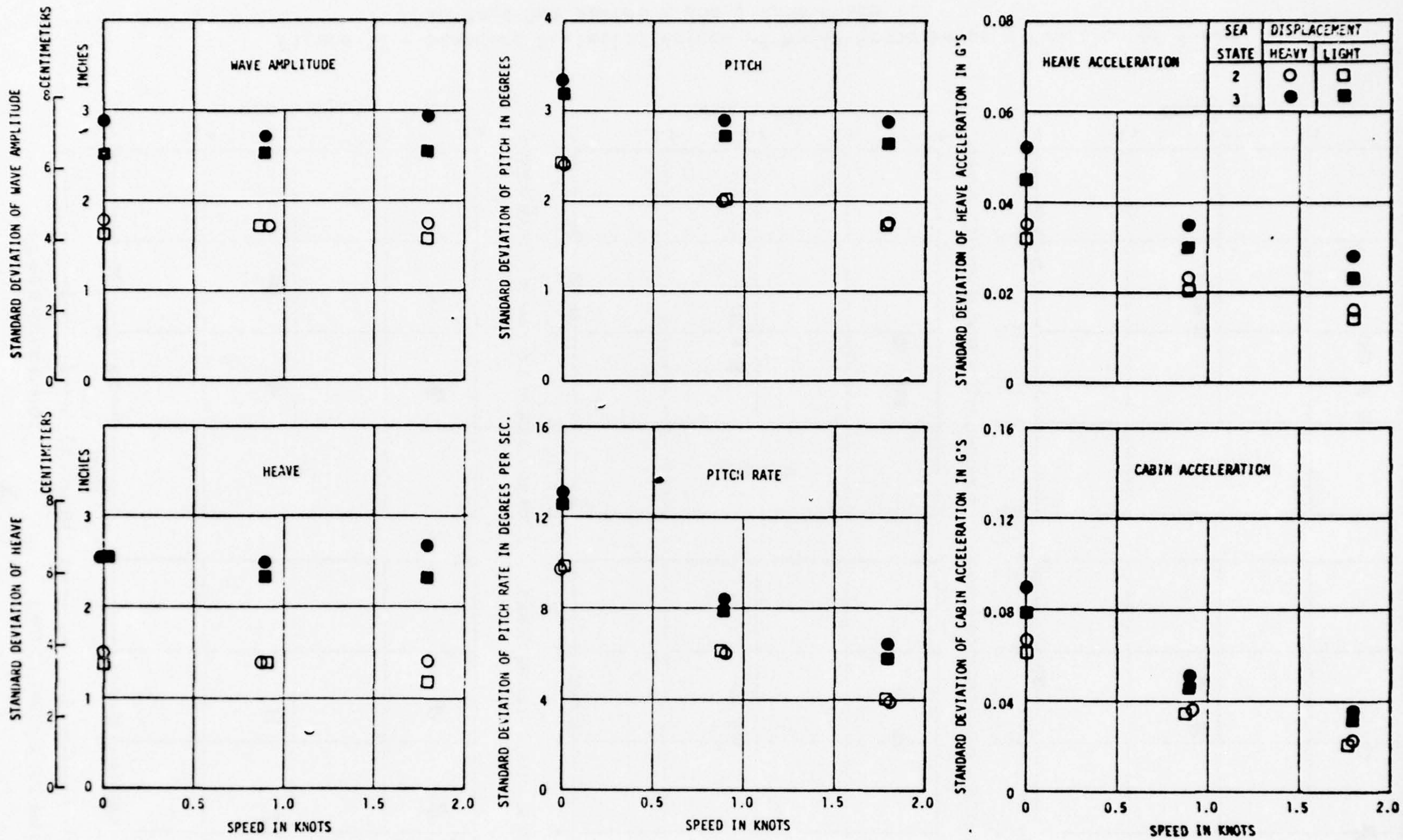

Figure 16 - Standard Deviation Values of Model Response as a Function of Speed in Following Sea States 2 and 3 from Phase 1

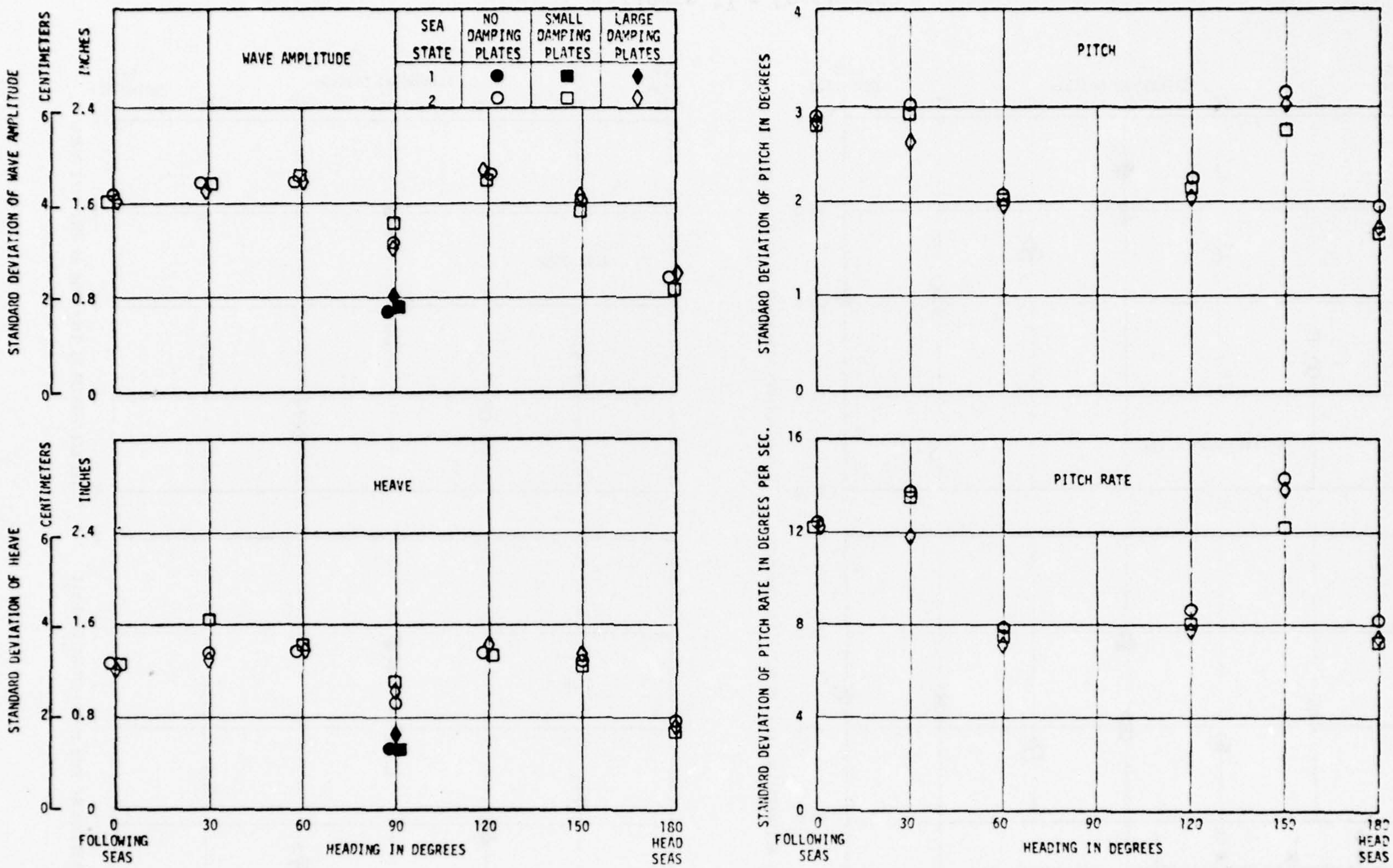

Figure 17 - Standard Deviation Values of Model Response at Zero Speed as a Function of Heading in Sea States 1 and 2 from Phase 2

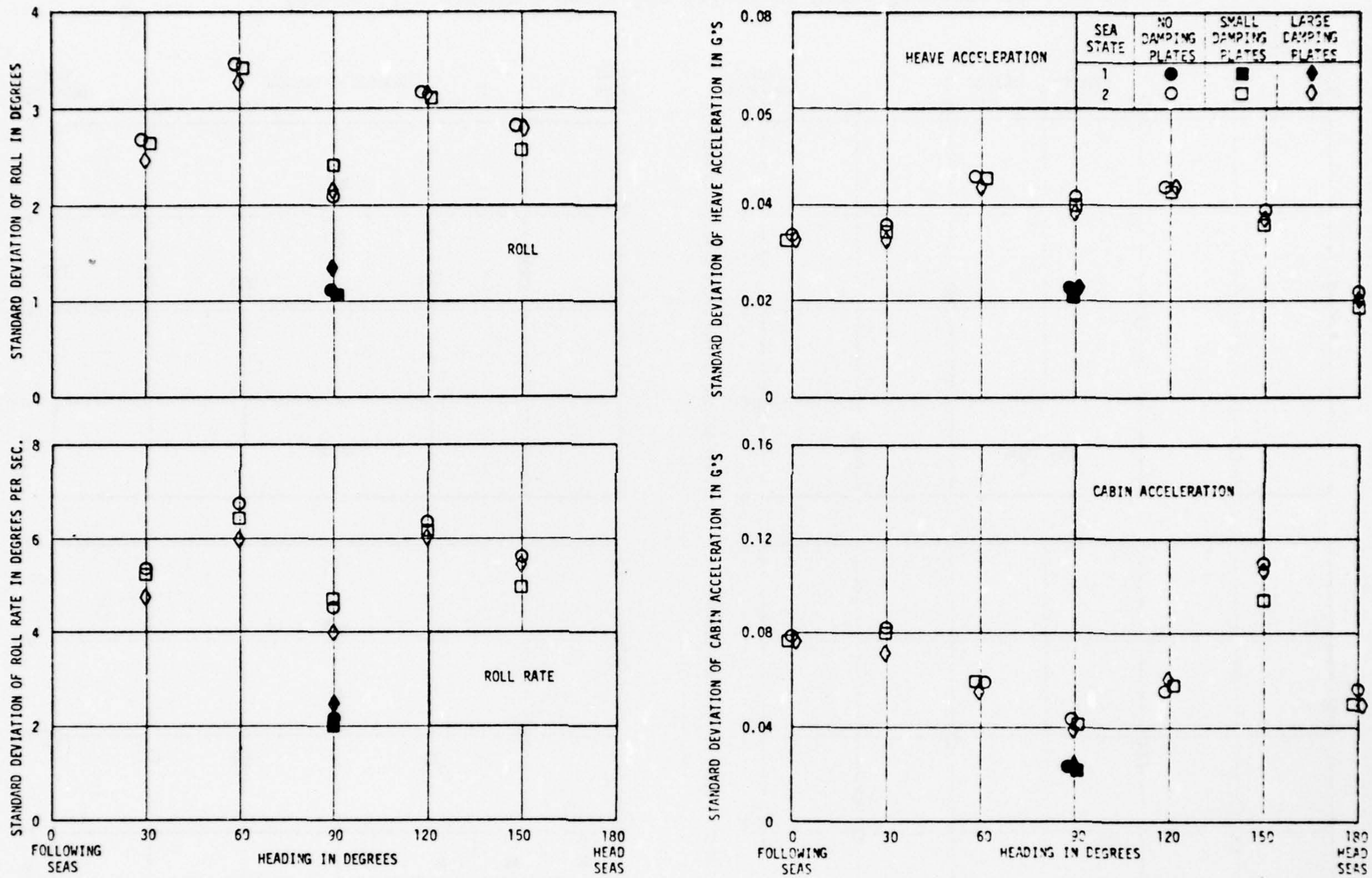

Figure 17 - Concluded

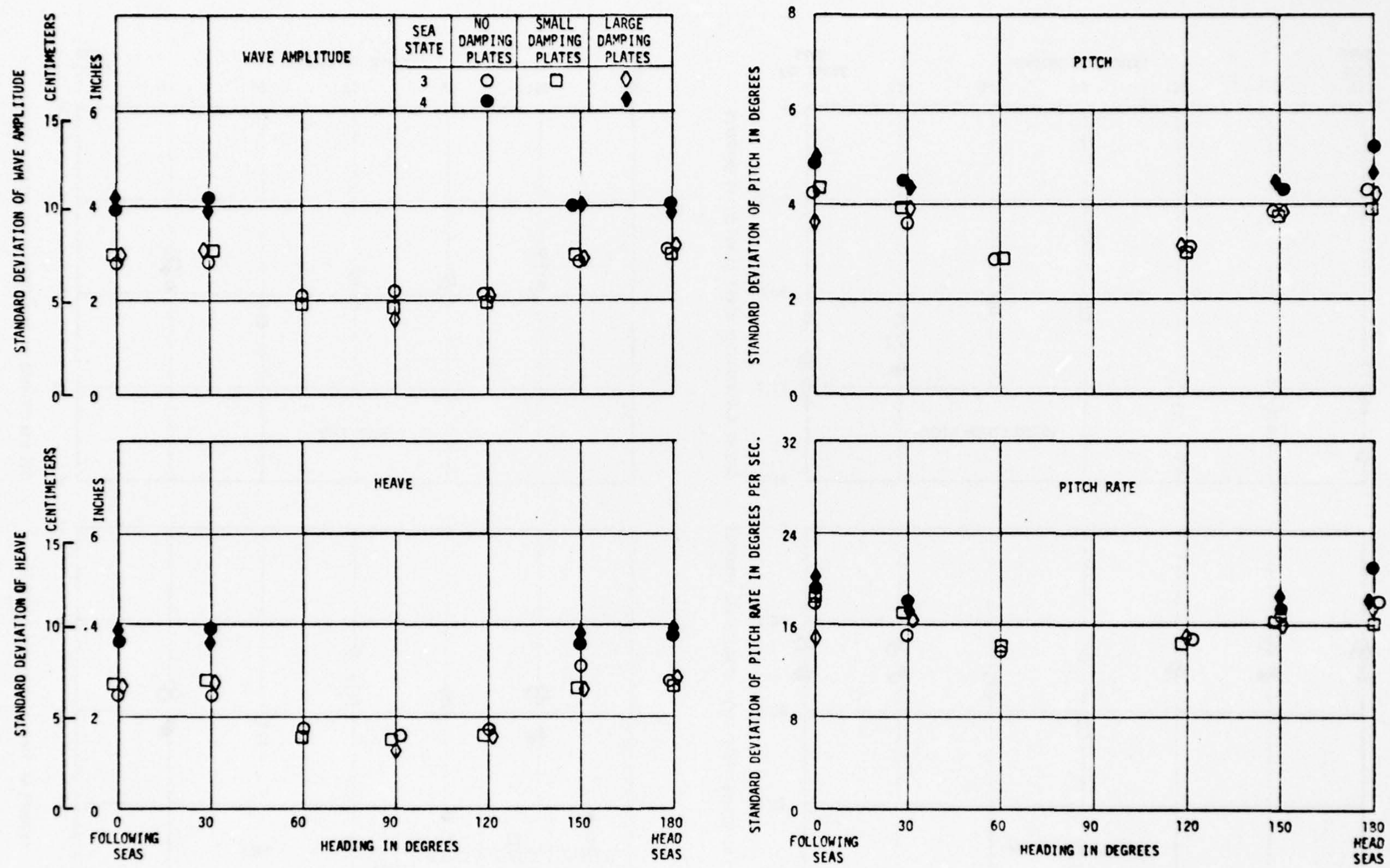

Figure 18 - Standard Deviation Values of Model Response at Zero Speed as a Function of Heading in Sea States 3 and 4 from Phase 2

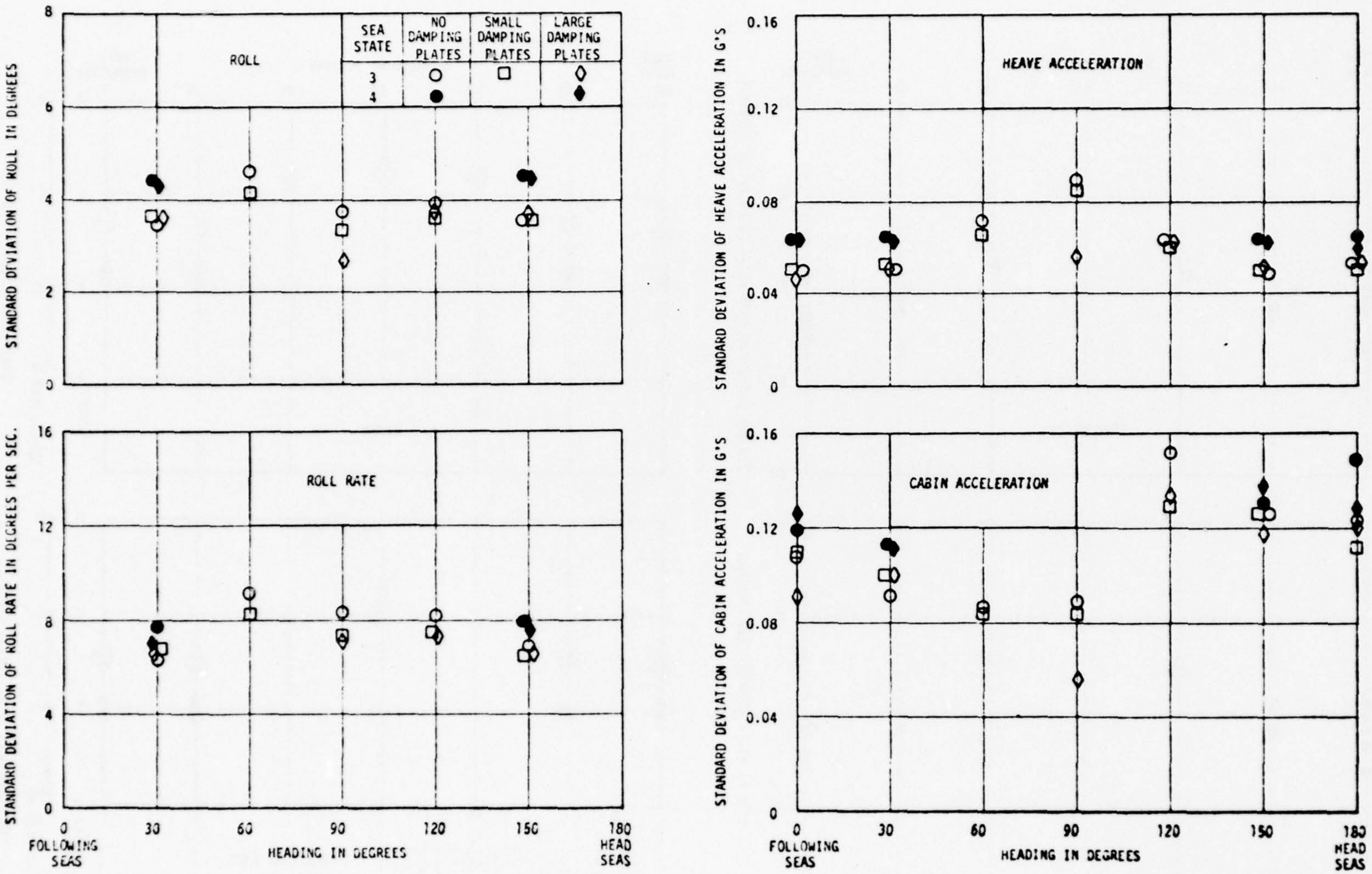

Figure 18 - Concluded

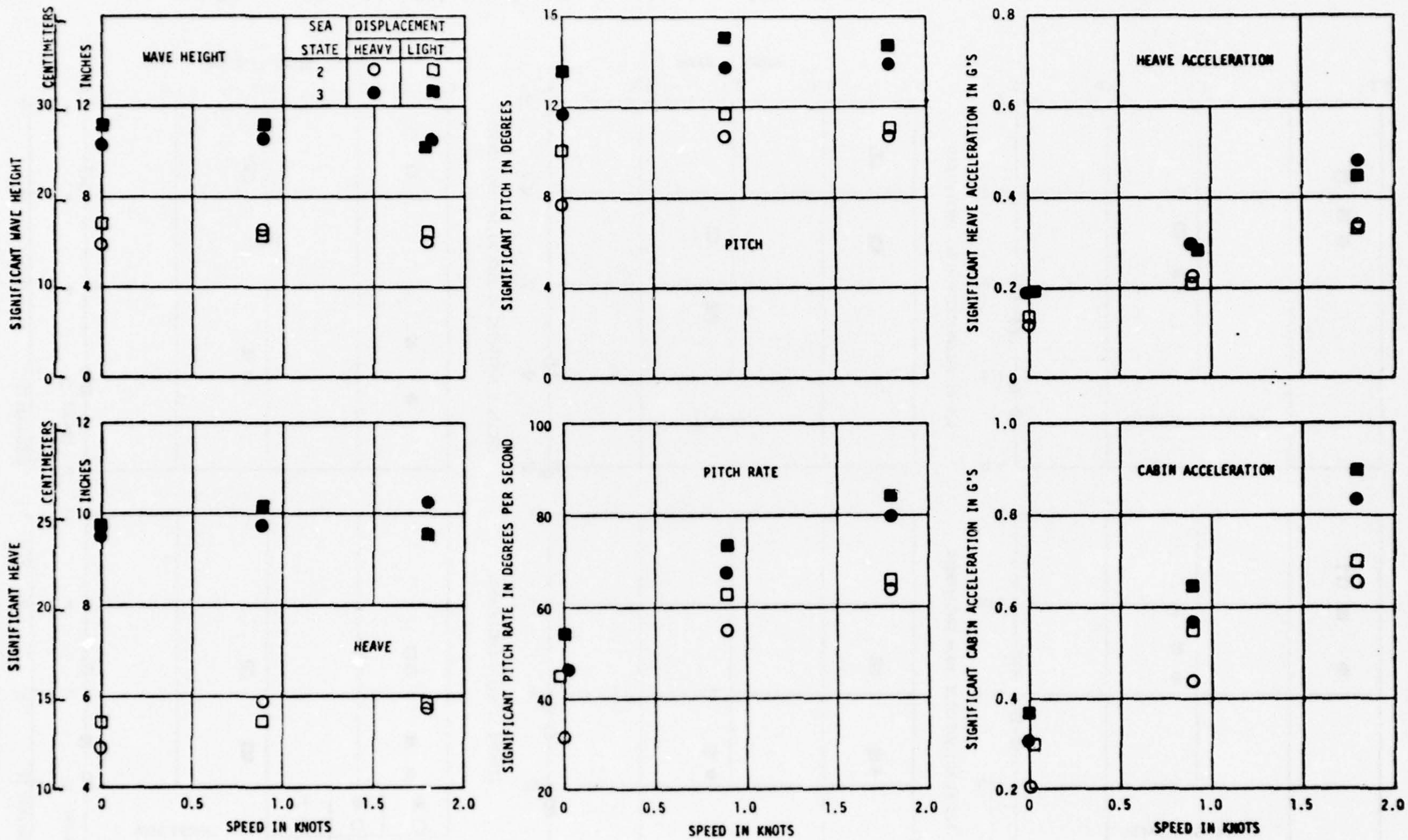

Figure 19 - Significant Double Amplitudes of Model Response as a Function of Speed in Head Sea States 2 and 3 from Phase 1

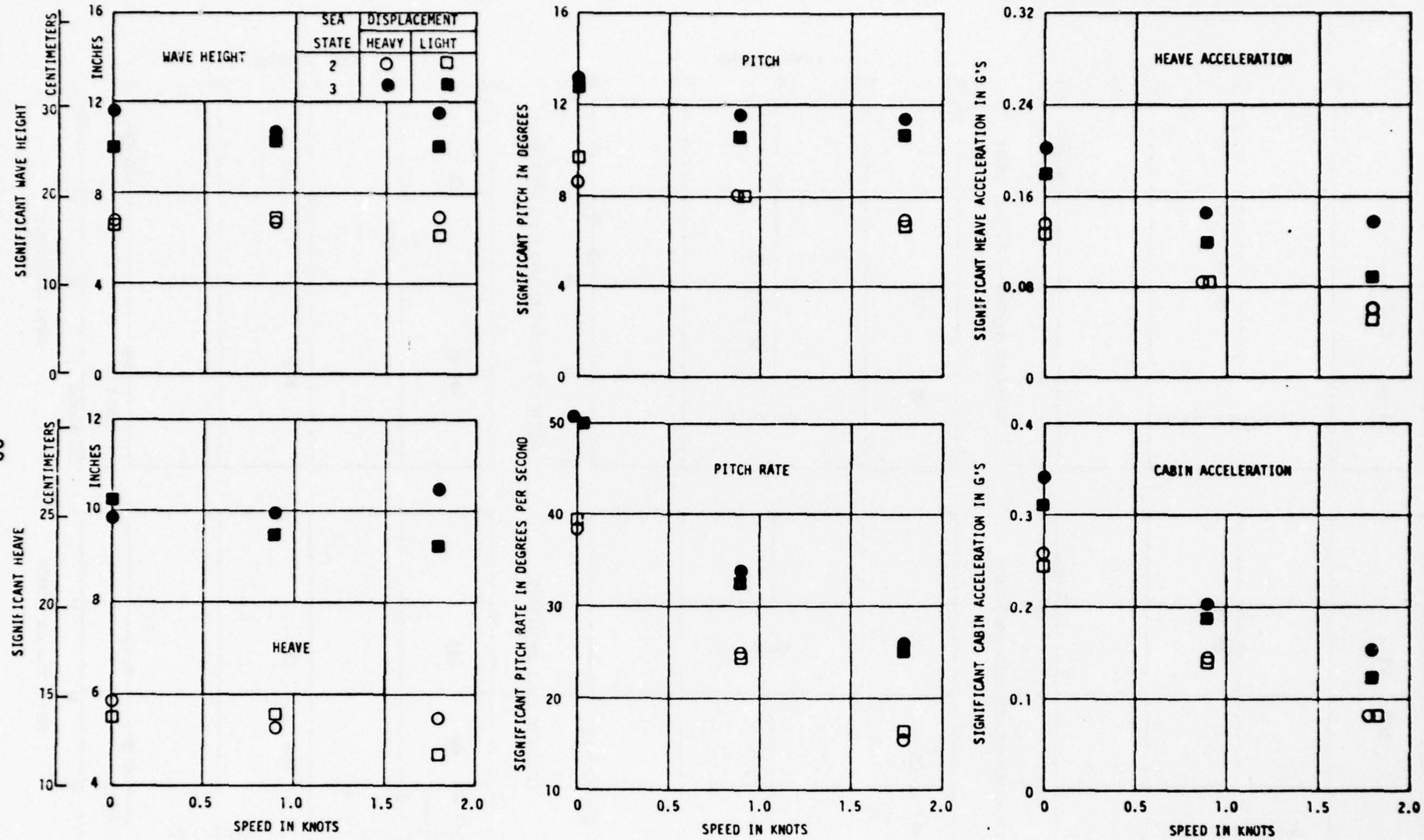

Figure 20 - Significant Double Amplitudes of Model Response as a Function of Speed in Following Sea States 2 and 3 from Phase 1

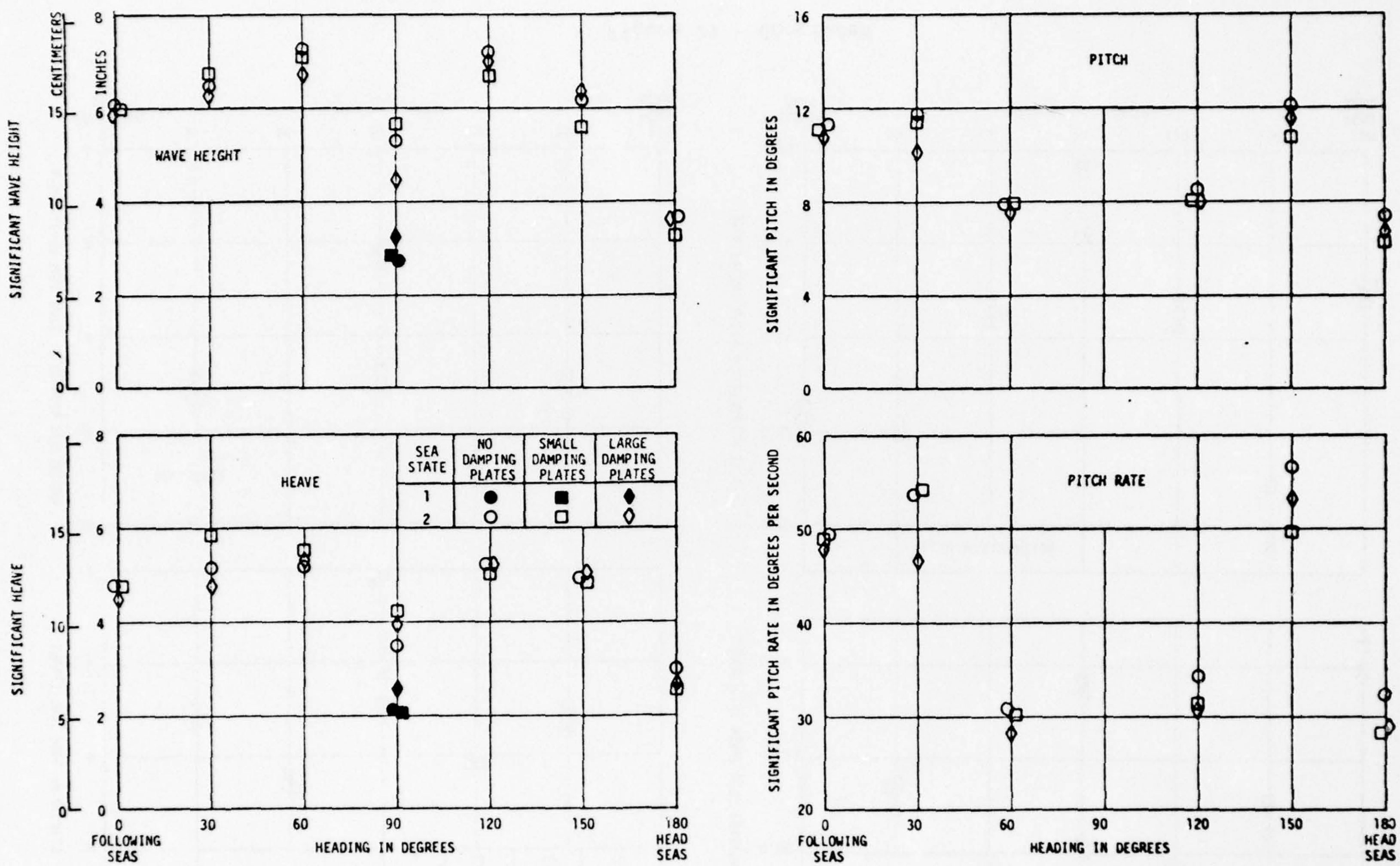

Figure 21 - Significant Double Amplitudes of Model Response at Zero Speed as a Function of Heading in Sea States 1 and 2 from Phase 2

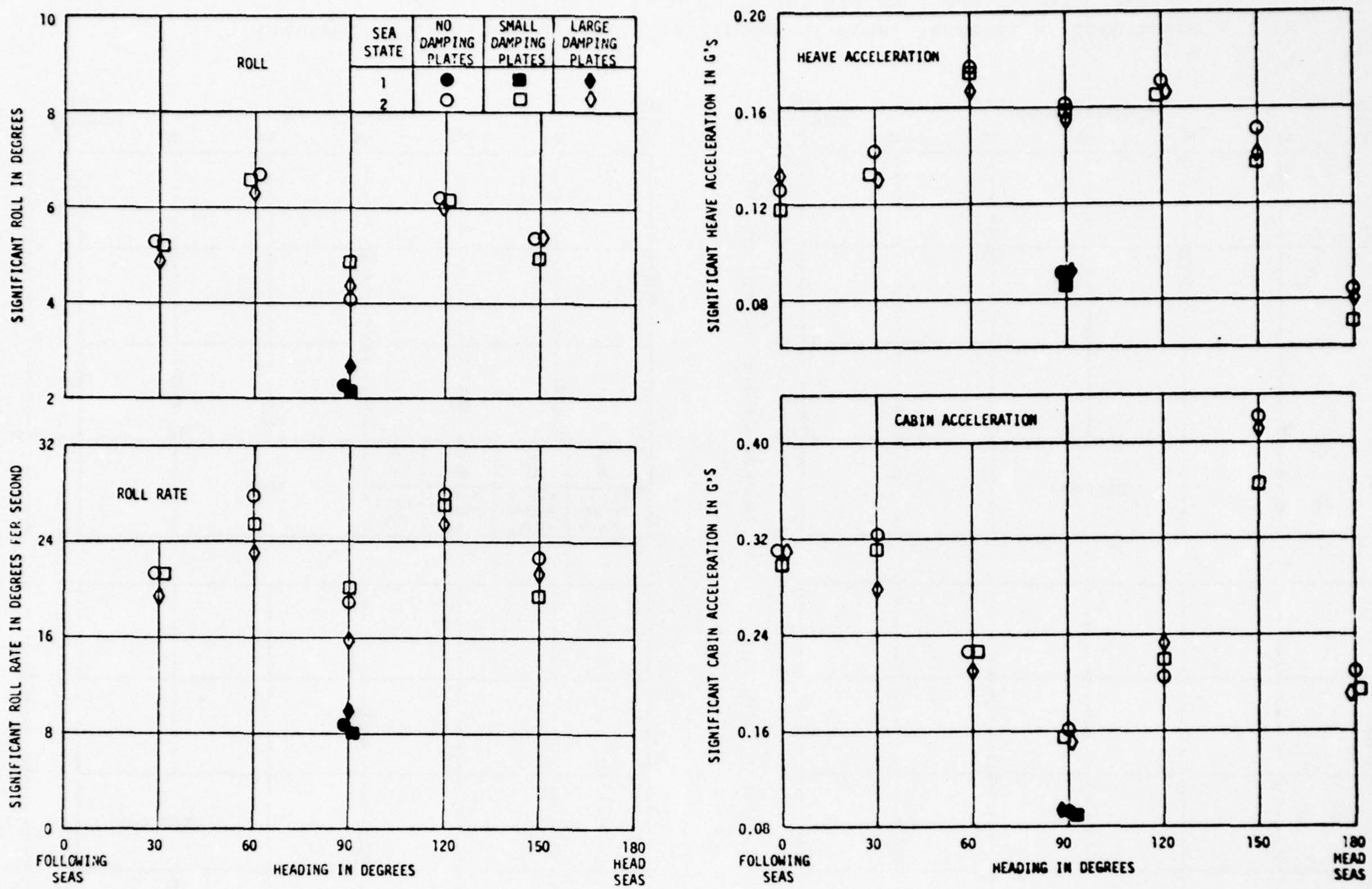

Figure 21 - Concluded

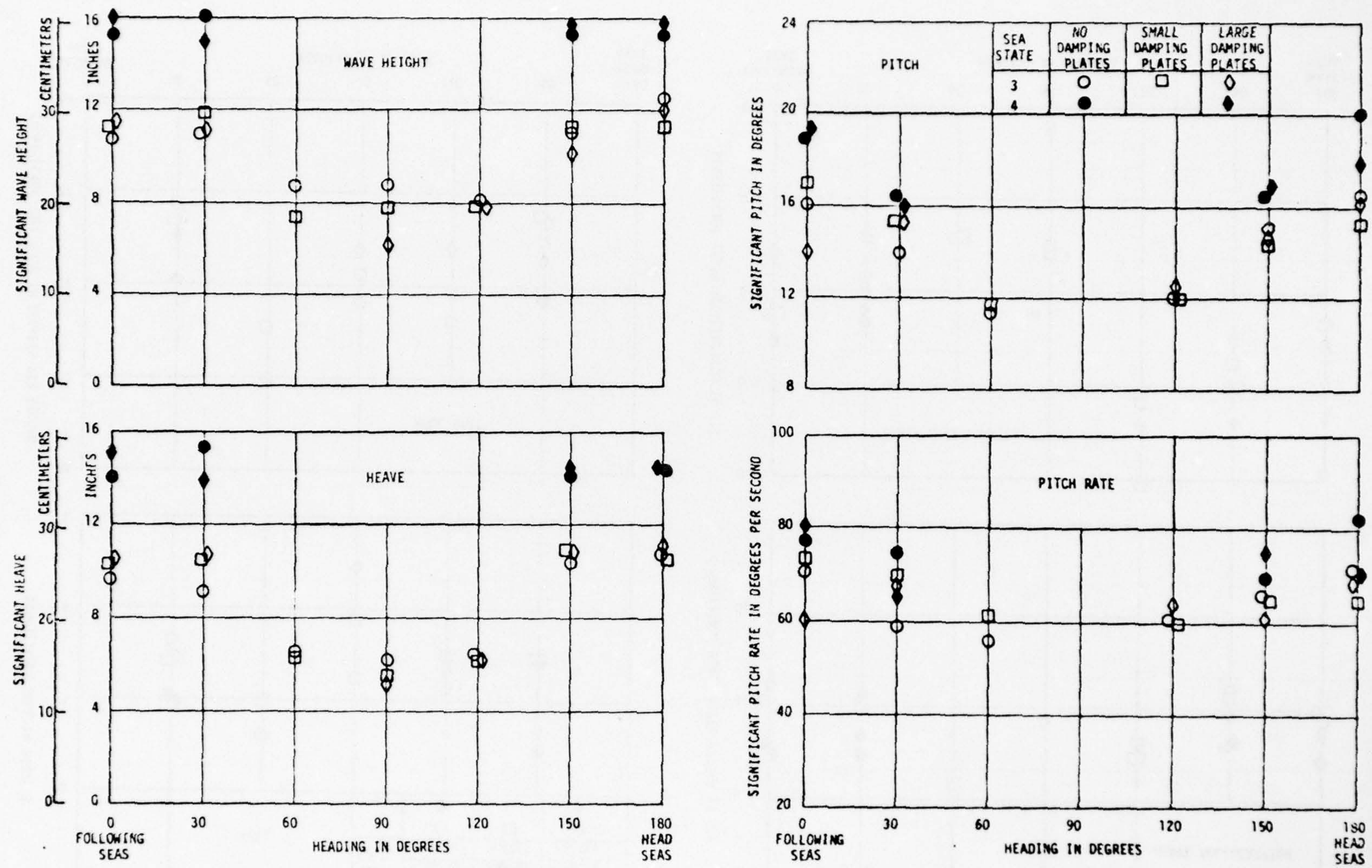

Figure 22 - Significant Double Amplitudes of Model Response at Zero Speed as a *Function of Heading* in Sea States 3 and 4 from Phase 2

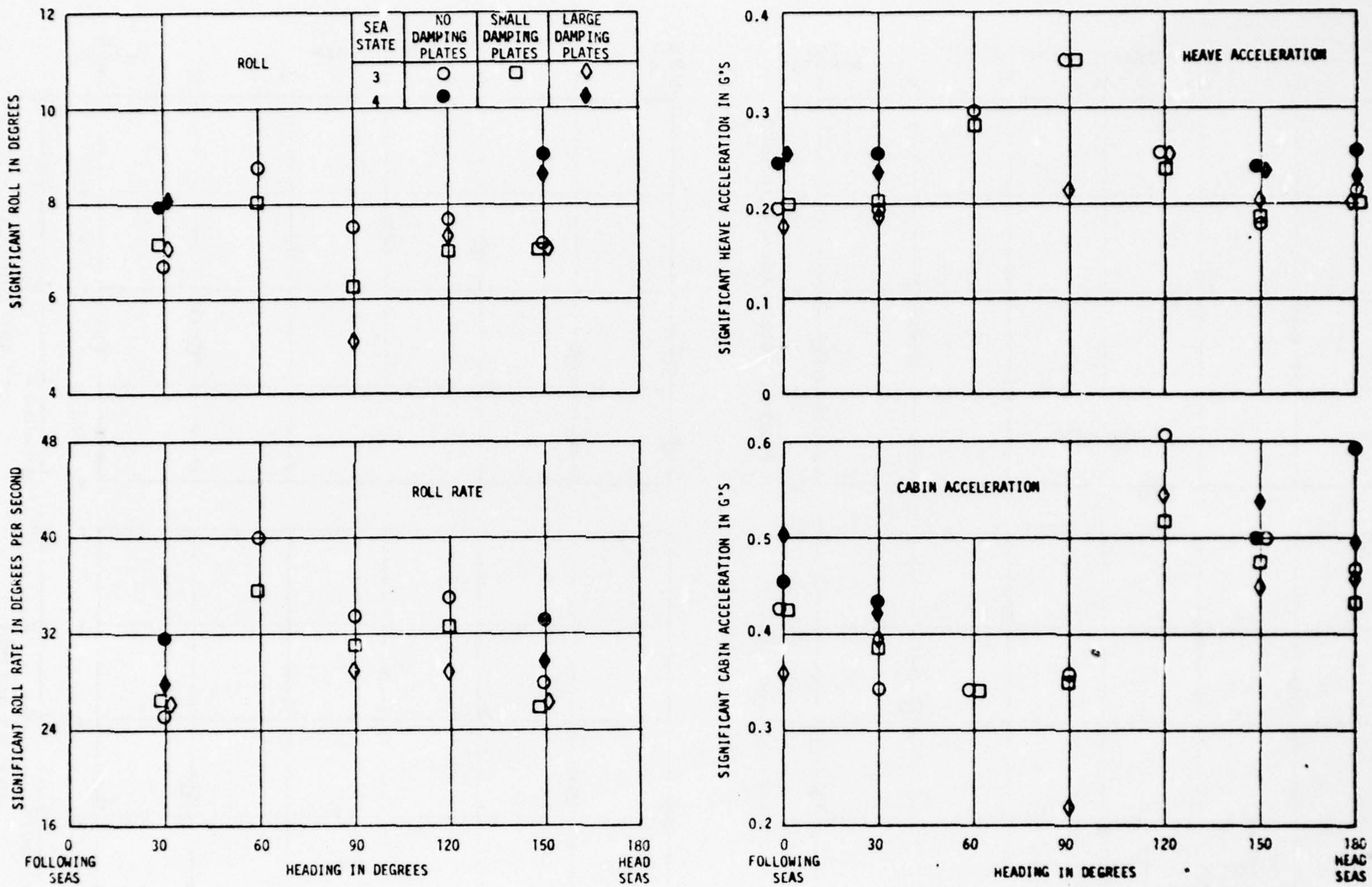

Figure 22 - Concluded

Figure 23 - Drag of the Seaplane Model in a Seaway from Phase 1

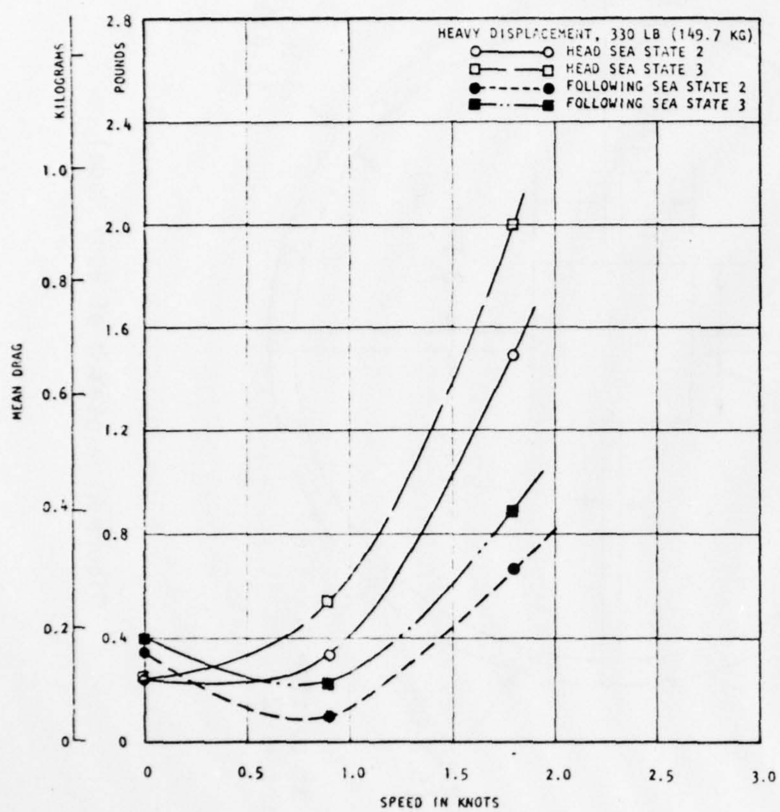

Figure 23a - Heavy Displacement

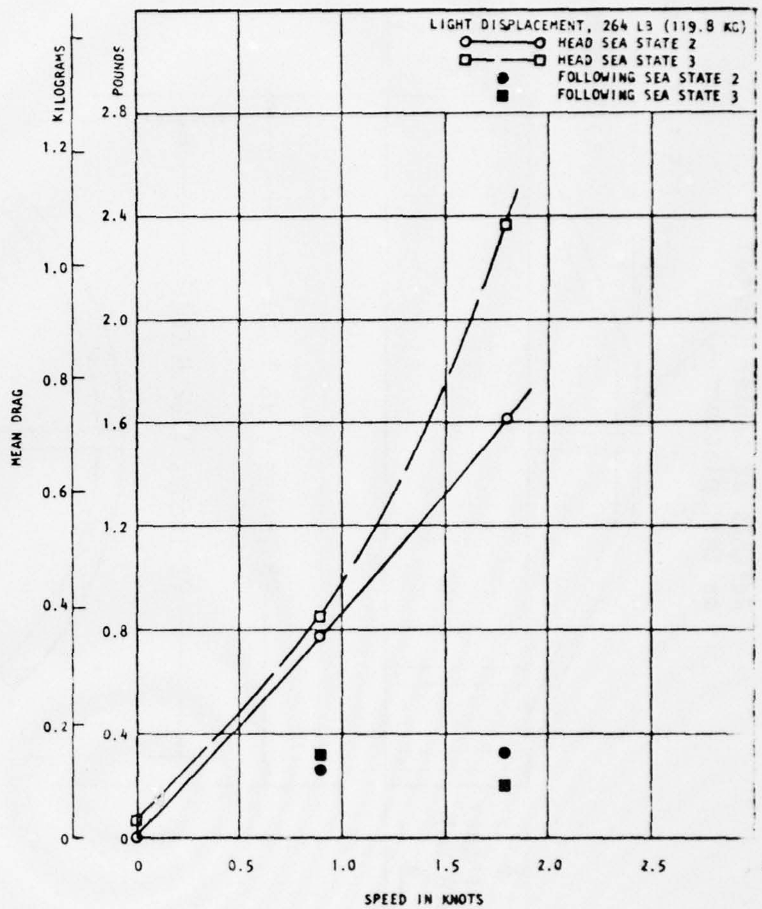

Figure 23b - Light Displacement

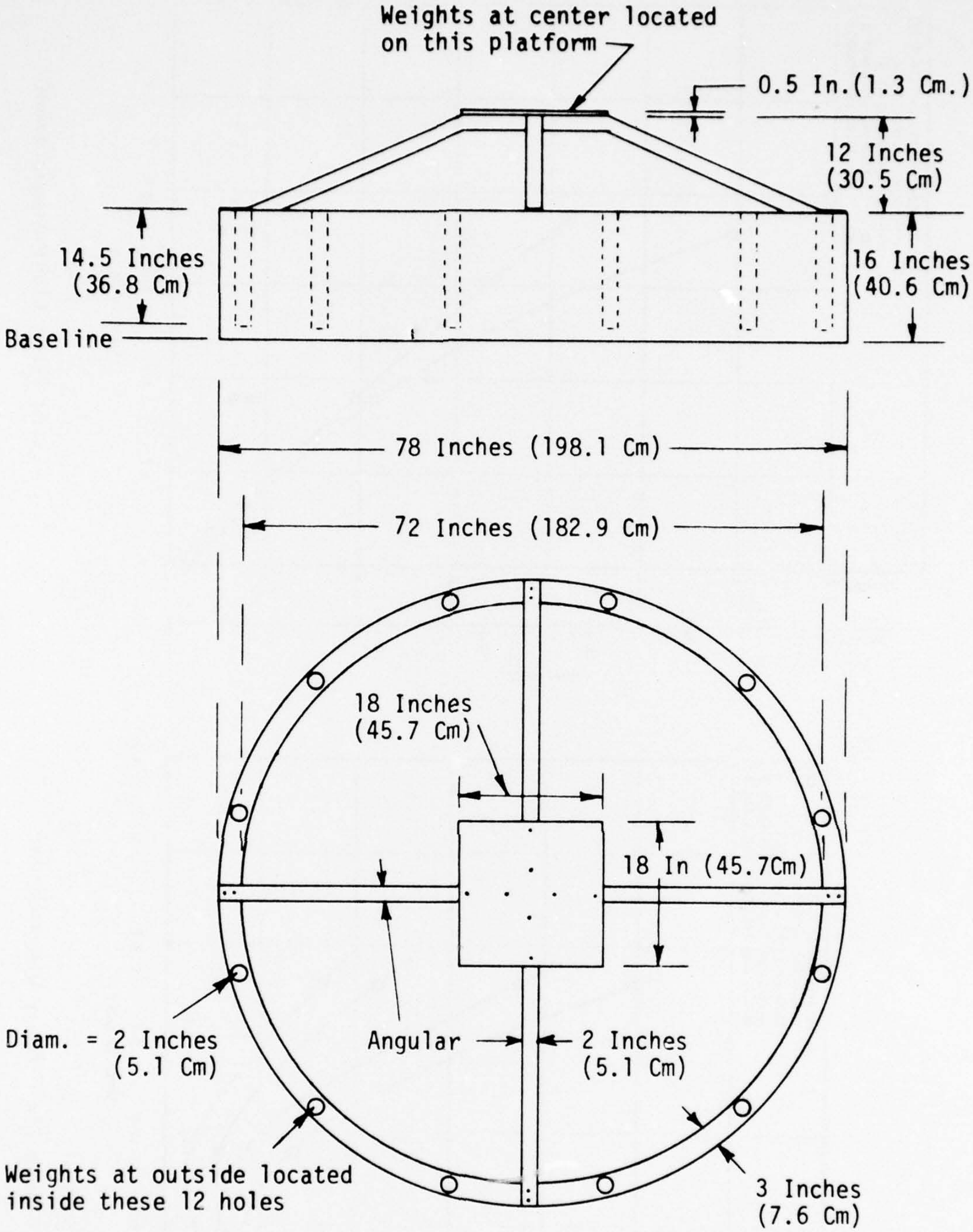

Figure A1 - Sketch of Buoy Model

Figure A2 - Transfer Functions for Buoy Model Obtained in Regular Waves

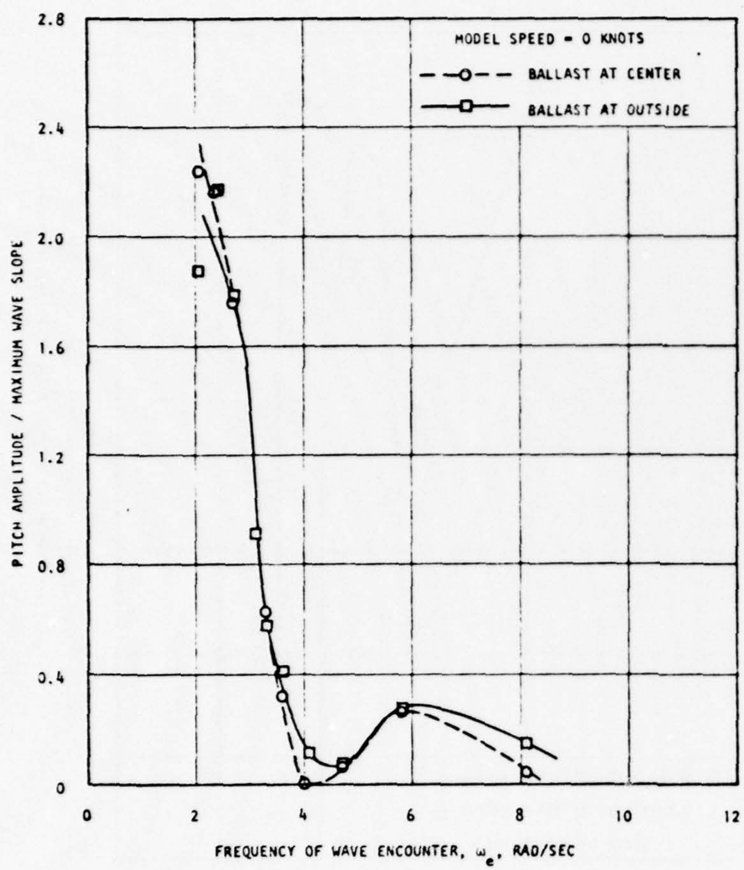

Figure A2a - Pitch Transfer Function

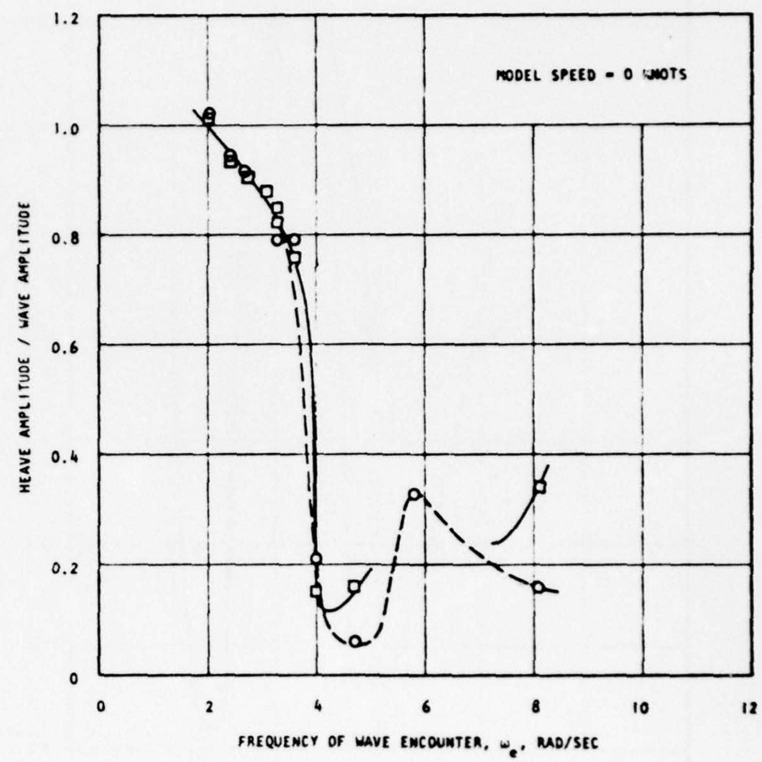

Figure A2b - Heave Transfer Function

Figure A2 - Concluded

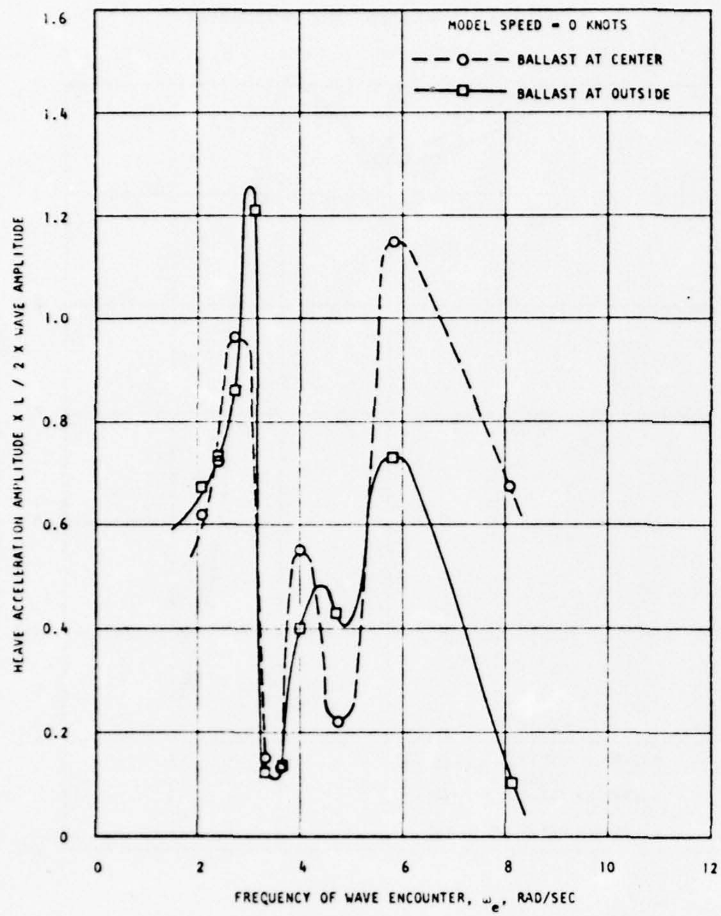

Figure A2c - Heave Acceleration Transfer Function

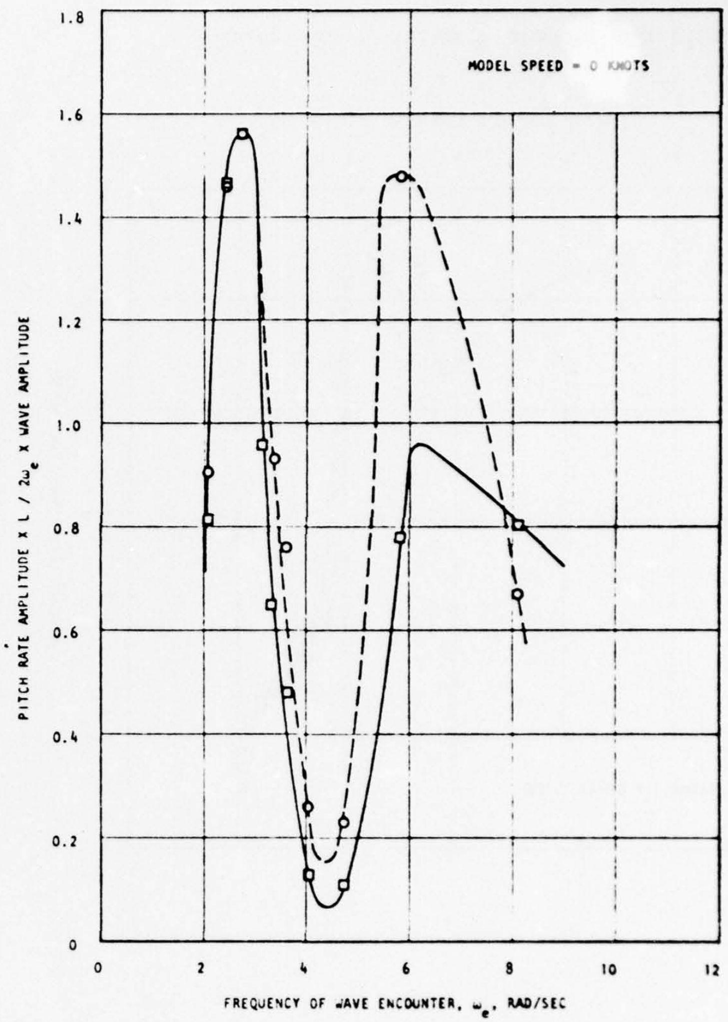

Figure A2d - Pitch Rate Transfer Function

TABLE 1

PRINCIPAL CHARACTERISTICS OF SEA LOITER AIRCRAFT MODEL

GENERAL ITEMS	ENGLISH	METRIC
LENGTH, OVERALL......................	8.00 FEET	2.44 METERS
HULL BEAM, MAXIMUM....................	1.60 FEET	0.49 METER
WING SPAN............................	9.60 FEET	2.93 METERS
WING FLOAT, MAXIMUM DIAMETER..........	0.60 FEET	0.18 METER
LONGITUDINAL LOCATION OF CG, AFT OF BOW	3.90 FEET	1.19 METERS
SCALE RATIO FOR RANDOM WAVE RUNS.......	1 : 5	1 : 5

PHASE 1	HEAVY DISPLACEMENT		LIGHT DISPLACEMENT	
	ENGLISH	METRIC	ENGLISH	METRIC
WEIGHT................................	330.0 POUNDS	149.7 KGS	264.0 POUNDS	119.8 KGS
VERTICAL LOCATION OF CG ABOVE BASELINE.	0.99 FEET	0.30 METER	0.99 FEET	0.30 METER
PITCH MOMENT OF INERTIA...............	30.0 SLUG-FT^2	40.68 KG-M^2	30.0 SLUG-FT^2	40.68 KG-M^2
ROLL MOMENT OF INERTIA................	30.0 SLUG-FT^2	40.68 KG-M^2	30.0 SLUG-FT^2	40.68 KG-M^2
PITCH NATURAL PERIOD..................	0.95 SECONDS	0.95 SECONDS	0.93 SECONDS	0.93 SECONDS
HEAVE NATURAL PERIOD..................	1.03 SECONDS	1.03 SECONDS	1.05 SECONDS	1.05 SECONDS
ROLL NATURAL PERIOD...................	0.90 SECONDS	0.90 SECONDS	1.28 SECONDS	1.28 SECONDS

PHASE 2	ENGLISH	METRIC
WEIGHT................................	327.0 POUNDS	148.3 KGS
VERTICAL LOCATION OF CG ABOVE BASELINE.	1.13 FEET	0.35 METER
PITCH MOMENT OF INERTIA...............	42.7 SLUG-FT^2	57.90 KG-M^2
ROLL MOMENT OF INERTIA................	17.3 SLUG-FT^2	23.46 KG-M^2
PITCH NATURAL PERIOD..................	1.15 SECONDS	1.15 SECONDS
HEAVE NATURAL PERIOD..................	1.00 SECONDS	1.00 SECONDS
ROLL NATURAL PERIOD...................	0.75 SECONDS	0.75 SECONDS

TABLE 2

TYPE AND RANGE OF TRANSDUCERS USED
FOR SEAPLANE EXPERIMENTS

MEASUREMENT	TRANSDUCER		RANGE	
	PHASE 1	PHASE 2	PHASE 1	PHASE 2
PITCH, ROLL	POTENTIOMETER	DISPLACEMENT GYRO	± 25 DEG., ± 35 DEG.	± 52 DEG., ± 100 DEG.
HEAVE	POTENTIOMETER	ULTRASONIC PROBE	± 8.5 IN. (21.6 CM.)	± 25 IN. (63.5 CM.)
PITCH RATE, ROLL RATE	RATE GYRO	RATE GYRO	90 DEGREES / SECOND	90 DEGREES / SECOND
YAW RATE	-	RATE GYRO	-	20 DEGREES / SECOND
YAW	-	DISPLACEMENT GYRO	-	± 100 DEGREES
HEAVE ACCELERATION	SERVO ACCELEROMETER	SERVO ACCELEROMETER	± 2 G.	± 1 G.
CABIN ACCELERATION	SERVO ACCELEROMETER	SERVO ACCELEROMETER	± 5 G.	± 5 G.
WING TIP ACCELERATION	-	SERVO ACCELEROMETER	-	± 5 G.
SURGE AND SWAY	-	ULTRASONIC PROBE	-	UNLIMITED *
DRAG	BLOCK GAGE	-	25 LB. (11.34 KG.)	-
WAVE HEIGHT	ULTRASONIC PROBE	ULTRASONIC PROBE	± 25 IN. (63.5 CM.)	± 25 IN. (63.5 CM.)

* Range well beyond requirements for model experiments.

TABLE 3

INSTRUMENTATION AND COMPUTER NOTES

1. On PSHAFT computer printout the units for angular rates are given as radians per second but they are actually degrees per second.

2. For Runs 13 - 15 the pitch rate gyro overscaled.

3. Heave gage not working properly during Run 38.

4. There is a 1.5 G offset for cabin acceleration during Run 559.

5. Cabin acceleration transducer changed from ± 5 G range to ± 2 G range prior to Run 560. Calibration not changed.

6. For Run 594 the wave height transducer was malfunctioning resulting in drop-out on all positive peaks.

TABLE 4

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE FOR VARIOUS SPEEDS
FROM PHASE 1

TABLE 4a - HEAD SEA STATE 2

MEASUREMENT	UNITS	HEAVY DISPLACEMENT			LIGHT DISPLACEMENT		
		SPEED IN KNOTS			SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE AMPLITUDE	INCHES (CM)	1.50 (3.81)	1.71 (4.34)	1.60 (4.06)	1.78 (4.52)	1.71 (4.34)	1.66 (4.22)
HEAVE	INCHES (CM)	1.28 (3.25)	1.53 (3.89)	1.53 (3.89)	1.44 (3.66)	1.43 (3.63)	1.57 (3.99)
PITCH	DEGREES	2.02	2.83	2.84	2.63	3.05	2.94
PITCH RATE	DEGREES PER SEC	7.69	14.11	16.70	11.29	15.09	17.15
HEAVE ACCELERATION	G'S	0.030	0.056	0.086	0.034	0.054	0.084
CABIN ACCELERATION	G'S	0.054	0.116	0.168	0.077	0.136	0.182

TABLE 4b - HEAD SEA STATE 3

MEASUREMENT	UNITS	HEAVY DISPLACEMENT			LIGHT DISPLACEMENT		
		SPEED IN KNOTS			SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE AMPLITUDE	INCHES (CM)	2.74 (6.96)	2.85 (7.24)	2.76 (7.01)	2.87 (7.29)	2.89 (7.34)	2.78 (7.06)
HEAVE	INCHES (CM)	2.44 (6.20)	2.61 (6.63)	2.66 (6.76)	2.55 (6.48)	2.63 (6.68)	2.64 (6.71)
PITCH	DEGREES	3.14	3.60	3.83	3.60	3.97	4.05
PITCH RATE	DEGREES PER SEC	11.77	16.82	20.88	14.48	19.05	21.94
HEAVE ACCELERATION	G'S	0.049	0.075	0.121	0.051	0.074	0.119
CABIN ACCELERATION	G'S	0.083	0.139	0.213	0.100	0.161	0.235

TABLE 4c - BEAM SEA STATE 2, 0 KNOTS

MEASUREMENT	UNITS	DISPLACEMENT	
		HEAVY	LIGHT
WAVE AMPLITUDE	INCHES (CM)	1.18 (3.00)	1.15 (2.92)
HEAVE	INCHES (CM)	1.09 (2.77)	1.17 (2.97)
ROLL	DEGREES	1.62	2.47
ROLL RATE	DEGREES PER SEC	9.52	13.62
HEAVE ACCELERATION	G'S	0.097	0.105
CABIN ACCELERATION	G'S	0.095	0.110

TABLE 4 - CONCLUDED

TABLE 4d - FOLLOWING SEA STATE 2

MEASUREMENT	UNITS	HEAVY DISPLACEMENT			LIGHT DISPLACEMENT		
		SPEED IN KNOTS			SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE AMPLITUDE	INCHES (CM)	1.77 (4.50)	1.72 (4.37)	1.74 (4.42)	1.63 (4.14)	1.72 (4.37)	1.58 (4.01)
HEAVE	INCHES (CM)	1.50 (3.81)	1.39 (3.53)	1.41 (3.58)	1.38 (3.51)	1.39 (3.53)	1.17 (2.97)
PITCH	DEGREES	2.40	2.01	1.77	2.41	2.02	1.74
PITCH RATE	DEGREES PER SEC	9.67	6.02	3.86	9.83	6.11	3.98
HEAVE ACCELERATION	G'S	0.035	0.023	0.016	0.032	0.021	0.014
CABIN ACCELERATION	G'S	0.066	0.036	0.022	0.061	0.035	0.021

TABLE 4e - FOLLOWING SEA STATE 3

MEASUREMENT	UNITS	HEAVY DISPLACEMENT			LIGHT DISPLACEMENT		
		SPEED IN KNOTS			SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE AMPLITUDE	INCHES (CM)	2.89 (7.34)	2.72 (6.91)	2.94 (7.47)	2.51 (6.38)	2.53 (6.43)	2.55 (6.48)
HEAVE	INCHES (CM)	2.57 (6.53)	2.49 (6.32)	2.67 (6.78)	2.56 (6.50)	2.34 (5.94)	2.32 (5.89)
PITCH	DEGREES	3.34	2.90	2.88	3.19	2.73	2.63
PITCH RATE	DEGREES PER SEC	13.10	8.45	6.37	12.50	7.86	5.93
HEAVE ACCELERATION	G'S	0.052	0.035	0.028	0.045	0.030	0.023
CABIN ACCELERATION	G'S	0.090	0.051	0.035	0.078	0.046	0.032

TABLE 5

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE AT ZERO SPEED
AND 180 DEGREE HEADING FROM PHASE 2

TABLE 5a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	0.96 (2.44)	0.85 (2.16)	0.93 (2.49)
HEAVE	INCHES (CM)	0.77 (1.96)	0.67 (1.70)	0.72 (1.83)
PITCH	DEGREES	1.94	1.66	1.72
PITCH RATE	DEGREES PER SEC	8.15	7.21	7.28
HEAVE ACCELERATION	G'S	0.022	0.019	0.021
CABIN ACCELERATION	G'S	0.056	0.050	0.050

TABLE 5b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	3.10 (7.87)	3.00 (7.62)	3.14 (7.98)
HEAVE	INCHES (CM)	2.84 (7.21)	2.63 (6.68)	2.89 (7.34)
PITCH	DEGREES	4.29	3.89	4.22
PITCH RATE	DEGREES PER SEC	17.98	16.18	17.59
HEAVE ACCELERATION	G'S	0.053	0.050	0.053
CABIN ACCELERATION	G'S	0.123	0.112	0.121

TABLE 5c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	4.01 (10.19)	3.91 (9.93)
HEAVE	INCHES (CM)	3.83 (9.73)	3.92 (9.96)
PITCH	DEGREES	5.21	4.64
PITCH RATE	DEGREES PER SEC	21.14	18.23
HEAVE ACCELERATION	G'S	0.065	0.060
CABIN ACCELERATION	G'S	0.149	0.129

TABLE 6

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE AT ZERO SPEED
AND 150 DEGREE HEADING FROM PHASE 2

TABLE 6a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	1.62 (4.11)	1.53 (3.89)	1.66 (4.22)
HEAVE	INCHES (CM)	1.29 (3.28)	1.26 (3.20)	1.34 (3.40)
PITCH	DEGREES	3.14	2.76	3.03
PITCH RATE	DEGREES PER SEC	14.27	12.20	13.83
ROLL	DEGREES	1.41	1.28	1.40
ROLL RATE	DEGREES PER SEC	5.60	4.96	5.47
HEAVE ACCELERATION	G'S	0.039	0.036	0.037
CABIN ACCELERATION	G'S	0.109	0.094	0.107

TABLE 6b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	2.90 (7.37)	2.96 (7.52)	2.94 (7.48)
HEAVE	INCHES (CM)	3.04 (7.72)	2.68 (6.81)	2.67 (6.78)
PITCH	DEGREES	3.82	3.76	3.78
PITCH RATE	DEGREES PER SEC	16.78	16.37	15.91
ROLL	DEGREES	1.82	1.80	1.86
ROLL RATE	DEGREES PER SEC	6.84	6.52	6.59
HEAVE ACCELERATION	G'S	0.049	0.050	0.052
CABIN ACCELERATION	G'S	0.126	0.126	0.118

TABLE 6c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	4.00 (10.16)	4.01 (10.19)
HEAVE	INCHES (CM)	3.60 (9.14)	3.81 (9.68)
PITCH	DEGREES	4.31	4.45
PITCH RATE	DEGREES PER SEC	17.47	18.55
ROLL	DEGREES	2.26	2.22
ROLL RATE	DEGREES PER SEC	7.92	7.55
HEAVE ACCELERATION	G'S	0.064	0.063
CABIN ACCELERATION	G'S	0.131	0.138

TABLE 7

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE AT ZERO SPEED
AND 120 DEGREE HEADING FROM PHASE 2

TABLE 7a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	1.85 (4.70)	1.79 (4.55)	1.87 (4.75)
HEAVE	INCHES (CM)	1.36 (3.45)	1.34 (3.40)	1.42 (3.61)
PITCH	DEGREES	2.24	2.13	2.06
PITCH RATE	DEGREES PER SEC	8.65	8.06	7.70
ROLL	DEGREES	1.58	1.57	1.58
ROLL RATE	DEGREES PER SEC	6.39	6.16	6.04
HEAVE ACCELERATION	G'S	0.044	0.043	0.044
CABIN ACCELERATION	G'S	0.055	0.057	0.061

TABLE 7b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	2.06 (5.23)	2.03 (5.16)	2.10 (5.33)
HEAVE	INCHES (CM)	1.65 (4.19)	1.60 (4.06)	1.62 (4.11)
PITCH	DEGREES	3.06	3.01	3.08
PITCH RATE	DEGREES PER SEC	14.84	14.56	15.14
ROLL	DEGREES	1.96	1.84	1.88
ROLL RATE	DEGREES PER SEC	8.24	7.54	7.27
HEAVE ACCELERATION	G'S	0.064	0.060	0.063
CABIN ACCELERATION	G'S	0.152	0.129	0.134

TABLE 8

SUMMARY OF STANDARD DEVIATION VALUES OF MODEL RESPONSE AT ZERO SPEED AND 90 DEGREE HEADING FROM PHASE 2

TABLE 8a - SEA STATE 1

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	0.68 (1.73)	0.70 (1.78)	0.81 (2.06)
HEAVE	INCHES (CM)	0.53 (1.35)	0.52 (1.32)	0.65 (1.65)
ROLL	DEGREES	0.56	0.53	0.68
ROLL RATE	DEGREES PER SEC	2.14	1.99	2.45
HEAVE ACCELERATION	G'S	0.023	0.021	0.023
CABIN ACCELERATION	G'S	0.023	0.022	0.024

TABLE 8b - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	1.26 (3.20)	1.43 (3.63)	1.21 (3.07)
HEAVE	INCHES (CM)	0.92 (2.34)	1.11 (2.82)	1.02 (2.59)
ROLL	DEGREES	1.06	1.20	1.07
ROLL RATE	DEGREES PER SEC	4.52	4.70	3.99
HEAVE ACCELERATION	G'S	0.042	0.040	0.039
CABIN ACCELERATION	G'S	0.043	0.040	0.039

TABLE 8c - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	2.19 (5.56)	1.85 (4.70)	1.62 (4.11)
HEAVE	INCHES (CM)	1.53 (3.89)	1.47 (3.73)	1.32 (3.35)
ROLL	DEGREES	1.87	1.67	1.34
ROLL RATE	DEGREES PER SEC	8.33	7.31	7.06
HEAVE ACCELERATION	G'S	0.089	0.085	0.056
CABIN ACCELERATION	G'S	0.089	0.084	0.057

TABLE 9

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE AT ZERO SPEED
AND 60 DEGREE HEADING FROM PHASE 2

TABLE 9a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	1.78 (4.52)	1.83 (4.65)	1.78 (4.52)
HEAVE	INCHES (CM)	1.38 (3.51)	1.42 (3.61)	1.39 (3.53)
PITCH	DEGREES	2.06	2.01	1.96
PITCH RATE	DEGREES PER SEC	7.77	7.54	7.23
ROLL	DEGREES	1.72	1.70	1.63
ROLL RATE	DEGREES PER SEC	6.75	6.43	5.99
HEAVE ACCELERATION	G'S	0.046	0.046	0.044
CABIN ACCELERATION	G'S	0.059	0.059	0.055

TABLE 9b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	2.10 (5.33)	1.90 (4.83)
HEAVE	INCHES (CM)	1.71 (4.34)	1.59 (4.04)
PITCH	DEGREES	2.84	2.83
PITCH RATE	DEGREES PER SEC	13.78	14.23
ROLL	DEGREES	2.32	2.08
ROLL RATE	DEGREES PER SEC	9.35	8.34
HEAVE ACCELERATION	G'S	0.072	0.066
CABIN ACCELERATION	G'S	0.087	0.084

TABLE 10

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE AT ZERO SPEED
AND 30 DEGREE HEADING FROM PHASE 2

TABLE 10a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	1.76 (4.47)	1.78 (4.52)	1.70 (4.32)
HEAVE	INCHES (CM)	1.36 (3.45)	1.65 (4.19)	1.29 (3.28)
PITCH	DEGREES	3.01	2.93	2.64
PITCH RATE	DEGREES PER SEC	13.66	13.56	11.84
ROLL	DEGREES	1.34	1.32	1.23
ROLL RATE	DEGREES PER SEC	5.32	5.23	4.76
HEAVE ACCELERATION	G'S	0.036	0.035	0.033
CABIN ACCELERATION	G'S	0.081	0.080	0.071

TABLE 10b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	2.82 (7.16)	3.01 (7.65)	3.03 (7.70)
HEAVE	INCHES (CM)	2.44 (6.20)	2.74 (6.96)	2.72 (6.91)
PITCH	DEGREES	3.59	3.91	3.90
PITCH RATE	DEGREES PER SEC	15.09	17.13	16.82
ROLL	DEGREES	1.72	1.82	1.80
ROLL RATE	DEGREES PER SEC	6.28	6.68	6.50
HEAVE ACCELERATION	G'S	0.050	0.052	0.051
CABIN ACCELERATION	G'S	0.092	0.101	0.101

TABLE 10c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	4.17 (10.59)	3.90 (9.91)
HEAVE	INCHES (CM)	3.91 (9.93)	3.62 (9.19)
PITCH	DEGREES	4.46	4.34
PITCH RATE	DEGREES PER SEC	18.26	17.65
ROLL	DEGREES	2.21	2.14
ROLL RATE	DEGREES PER SEC	7.67	7.14
HEAVE ACCELERATION	G'S	0.065	0.063
CABIN ACCELERATION	G'S	0.113	0.112

TABLE 11

SUMMARY OF STANDARD DEVIATION VALUES
OF MODEL RESPONSE AT ZERO SPEED
AND 0 DEGREE HEADING FROM PHASE 2

TABLE 11a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	1.67 (4.24)	1.61 (4.09)	1.61 (4.09)
HEAVE	INCHES (CM)	1.26 (3.20)	1.25 (3.18)	1.21 (3.07)
PITCH	DEGREES	2.88	2.82	2.84
PITCH RATE	DEGREES PER SEC	12.44	12.19	12.20
HEAVE ACCELERATION	G'S	0.034	0.033	0.033
CABIN ACCELERATION	G'S	0.078	0.077	0.077

TABLE 11b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	2.83 (7.19)	2.97 (7.54)	2.91 (7.39)
HEAVE	INCHES (CM)	2.46 (6.25)	2.69 (6.83)	2.61 (6.63)
PITCH	DEGREES	4.21	4.32	3.62
PITCH RATE	DEGREES PER SEC	17.96	18.56	14.95
HEAVE ACCELERATION	G'S	0.050	0.051	0.046
CABIN ACCELERATION	G'S	0.108	0.110	0.092

TABLE 11c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE AMPLITUDE	INCHES (CM)	3.95 (10.03)	4.18 (10.62)
HEAVE	INCHES (CM)	3.62 (9.19)	3.59 (9.88)
PITCH	DEGREES	4.89	5.01
PITCH RATE	DEGREES PER SEC	19.29	20.36
HEAVE ACCELERATION	G'S	0.064	0.064
CABIN ACCELERATION	G'S	0.120	0.127

TABLE 12

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE FOR VARIOUS SPEEDS
FROM PHASE 1

TABLE 12a - HEAD SEA STATE 2

MEASUREMENT	UNITS	HEAVY DISPLACEMENT			LIGHT DISPLACEMENT		
		SPEED IN KNOTS			SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE HEIGHT	INCHES (CM)	5.84 (14.83)	6.51 (16.54)	5.99 (15.22)	6.79 (17.26)	6.21 (15.78)	6.39 (16.23)
HEAVE	INCHES (CM)	4.87 (12.36)	5.89 (14.96)	5.71 (14.50)	5.43 (13.80)	5.44 (13.82)	5.82 (14.78)
PITCH	DEGREES	7.65	10.70	10.61	10.08	11.64	11.01
PITCH RATE	DEGREES PER SEC	31.14	54.82	63.54	45.01	62.46	65.73
HEAVE ACCELERATION	G'S	0.112	0.221	0.333	0.132	0.206	0.329
CABIN ACCELERATION	G'S	0.205	0.437	0.651	0.299	0.545	0.699

TABLE 12b - HEAD SEA STATE 3

MEASUREMENT	UNITS	HEAVY DISPLACEMENT			LIGHT DISPLACEMENT		
		SPEED IN KNOTS			SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE HEIGHT	INCHES (CM)	10.38 (26.37)	10.59 (26.90)	10.57 (26.84)	11.19 (28.43)	11.15 (28.32)	10.14 (25.74)
HEAVE	INCHES (CM)	9.50 (24.13)	9.73 (24.72)	10.24 (26.01)	9.75 (24.76)	10.11 (25.67)	9.52 (24.17)
PITCH	DEGREES	11.66	13.74	13.85	13.57	15.06	14.67
PITCH RATE	DEGREES PER SEC	45.70	67.20	79.77	53.98	73.10	84.19
HEAVE ACCELERATION	G'S	0.187	0.295	0.479	0.190	0.281	0.444
CABIN ACCELERATION	G'S	0.308	0.565	0.832	0.368	0.647	0.896

TABLE 12c - BEAM SEA STATE 2, 0 KNOTS

MEASUREMENT	UNITS	DISPLACEMENT	
		HEAVY	LIGHT
WAVE HEIGHT	INCHES (CM)	4.49 (11.41)	4.92 (12.49)
HEAVE	INCHES (CM)	4.10 (10.41)	4.53 (11.50)
ROLL	DEGREES	6.20	9.43
ROLL RATE	DEGREES PER SEC	39.51	55.80
HEAVE ACCELERATION	G'S	0.368	0.412
CABIN ACCELERATION	G'S	0.366	0.434

TABLE 12 - CONCLUDED

TABLE 12d - FOLLOWING SEA STATE 2

MEASUREMENT	UNITS	HEAVY DISPLACEMENT SPEED IN KNOTS			LIGHT DISPLACEMENT SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE HEIGHT	INCHES (CM)	6.78 (17.21)	6.62 (16.81)	6.92 (17.58)	6.54 (16.61)	6.86 (17.42)	6.11 (15.53)
HEAVE	INCHES (CM)	5.83 (14.81)	5.26 (13.35)	5.44 (13.82)	5.50 (13.97)	5.55 (14.10)	4.69 (11.91)
PITCH	DEGREES	8.65	8.01	6.92	9.65	8.06	6.65
PITCH RATE	DEGREES PER SEC	38.22	24.67	15.36	39.34	24.43	16.18
HEAVE ACCELERATION	G'S	0.135	0.084	0.060	0.127	0.085	0.050
CABIN ACCELERATION	G'S	0.257	0.144	0.081	0.244	0.140	0.081

TABLE 12e - FOLLOWING SEA STATE 3

MEASUREMENT	UNITS	HEAVY DISPLACEMENT SPEED IN KNOTS			LIGHT DISPLACEMENT SPEED IN KNOTS		
		0	0.89	1.79	0	0.89	1.79
WAVE HEIGHT	INCHES (CM)	11.61 (29.48)	10.71 (27.20)	11.54 (29.31)	10.03 (25.47)	10.22 (25.95)	10.03 (25.49)
HEAVE	INCHES (CM)	9.83 (24.98)	9.91 (25.17)	10.49 (26.64)	10.24 (26.02)	9.44 (23.98)	9.20 (23.37)
PITCH	DEGREES	13.18	11.55	11.38	12.76	10.59	10.61
PITCH RATE	DEGREES PER SEC	50.52	33.78	25.78	50.00	32.47	24.96
HEAVE ACCELERATION	G'S	0.203	0.145	0.137	0.180	0.120	0.083
CABIN ACCELERATION	G'S	0.341	0.201	0.151	0.311	0.186	0.121

TABLE 13

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 180 DEGREE HEADING FROM PHASE 2

TABLE 13a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	3.67 (9.32)	3.26 (8.28)	3.62 (9.20)
HEAVE	INCHES (CM)	2.99 (7.59)	2.54 (6.44)	2.72 (6.92)
PITCH	DEGREES	7.35	6.21	6.73
PITCH RATE	DEGREES PER SEC	32.35	28.13	28.93
HEAVE ACCELERATION	G'S	0.084	0.071	0.081
CABIN ACCELERATION	G'S	0.209	0.193	0.191

TABLE 13b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	12.53 (31.83)	11.36 (28.84)	12.03 (30.55)
HEAVE	INCHES (CM)	10.74 (27.28)	10.44 (26.52)	11.06 (28.09)
PITCH	DEGREES	16.46	15.21	16.16
PITCH RATE	DEGREES PER SEC	71.25	64.47	68.65
HEAVE ACCELERATION	G'S	0.213	0.200	0.202
CABIN ACCELERATION	G'S	0.466	0.432	0.456

TABLE 13c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	15.33 (38.93)	15.82 (40.18)
HEAVE	INCHES (CM)	14.36 (36.47)	14.98 (38.04)
PITCH	DEGREES	20.03	17.91
PITCH RATE	DEGREES PER SEC	82.06	70.33
HEAVE ACCELERATION	G'S	0.255	0.229
CABIN ACCELERATION	G'S	0.593	0.495

TABLE 14

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 150 DEGREE HEADING FROM PHASE 2

TABLE 14a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	6.11 (15.53)	5.58 (14.16)	6.32 (16.05)
HEAVE	INCHES (CM)	4.93 (12.52)	4.84 (12.28)	5.09 (12.92)
PITCH	DEGREES	12.10	10.70	11.55
PITCH RATE	DEGREES PER SEC	56.58	49.61	53.30
ROLL	DEGREES	5.33	4.90	5.33
ROLL RATE	DEGREES PER SEC	22.49	19.40	21.30
HEAVE ACCELERATION	G'S	0.151	0.137	0.141
CABIN ACCELERATION	G'S	0.421	0.365	0.412

TABLE 14b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	11.05 (28.06)	11.36 (28.84)	10.19 (25.89)
HEAVE	INCHES (CM)	10.35 (26.29)	10.86 (27.59)	10.85 (27.55)
PITCH	DEGREES	15.09	14.33	14.66
PITCH RATE	DEGREES PER SEC	65.98	64.46	60.97
ROLL	DEGREES	7.18	7.02	7.02
ROLL RATE	DEGREES PER SEC	27.80	25.78	26.28
HEAVE ACCELERATION	G'S	0.179	0.187	0.203
CABIN ACCELERATION	G'S	0.497	0.474	0.448

TABLE 14c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	15.38 (39.07)	15.63 (39.71)
HEAVE	INCHES (CM)	14.02 (35.60)	14.43 (36.65)
PITCH	DEGREES	16.51	16.93
PITCH RATE	DEGREES PER SEC	69.29	74.98
ROLL	DEGREES	9.04	8.60
ROLL RATE	DEGREES PER SEC	33.14	29.68
HEAVE ACCELERATION	G'S	0.239	0.235
CABIN ACCELERATION	G'S	0.500	0.537

TABLE 15

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 120 DEGREE HEADING FROM PHASE 2

TABLE 15a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	7.19 (18.27)	6.65 (16.89)	6.96 (17.69)
HEAVE	INCHES (CM)	5.26 (13.35)	5.03 (12.77)	5.26 (13.37)
PITCH	DEGREES	8.47	8.09	8.01
PITCH RATE	DEGREES PER SEC	34.37	31.44	30.73
ROLL	DEGREES	6.18	6.13	5.99
ROLL RATE	DEGREES PER SEC	27.94	27.14	25.50
HEAVE ACCELERATION	G'S	0.171	0.165	0.166
CABIN ACCELERATION	G'S	0.204	0.219	0.233

TABLE 15b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	8.07 (20.49)	7.80 (19.80)	7.86 (19.96)
HEAVE	INCHES (CM)	6.37 (16.18)	6.04 (15.34)	6.17 (15.68)
PITCH	DEGREES	12.01	11.93	12.58
PITCH RATE	DEGREES PER SEC	60.41	59.56	63.57
ROLL	DEGREES	7.64	6.96	7.32
ROLL RATE	DEGREES PER SEC	34.91	32.51	28.70
HEAVE ACCELERATION	G'S	0.254	0.237	0.253
CABIN ACCELERATION	G'S	0.609	0.517	0.545

TABLE 16

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 90 DEGREE HEADING FROM PHASE 2

TABLE 16a - SEA STATE 1

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	2.73 (6.92)	2.82 (7.16)	3.23 (8.20)
HEAVE	INCHES (CM)	2.12 (5.39)	2.08 (5.29)	2.58 (6.55)
ROLL	DEGREES	2.22	2.12	2.69
ROLL RATE	DEGREES PER SEC	8.56	7.94	9.78
HEAVE ACCELERATION	G'S	0.091	0.086	0.092
CABIN ACCELERATION	G'S	0.092	0.089	0.094

TABLE 16b - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	5.29 (13.43)	5.66 (14.38)	4.44 (11.28)
HEAVE	INCHES (CM)	3.48 (8.83)	4.23 (10.75)	3.98 (10.12)
ROLL	DEGREES	4.07	4.64	4.32
ROLL RATE	DEGREES PER SEC	18.84	20.02	15.78
HEAVE ACCELERATION	G'S	0.161	0.158	0.155
CABIN ACCELERATION	G'S	0.160	0.153	0.150

TABLE 16c - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	8.75 (22.24)	7.76 (19.71)	6.09 (15.46)
HEAVE	INCHES (CM)	6.13 (15.57)	5.44 (13.83)	5.08 (12.90)
ROLL	DEGREES	7.48	6.22	5.09
ROLL RATE	DEGREES PER SEC	33.31	30.95	28.83
HEAVE ACCELERATION	G'S	0.354	0.351	0.214
CABIN ACCELERATION	G'S	0.358	0.348	0.218

TABLE 17

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 60 DEGREE HEADING FROM PHASE 2

TABLE 17a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	7.22 (18.33)	7.06 (17.94)	6.70 (17.02)
HEAVE	INCHES (CM)	5.19 (13.17)	5.52 (14.02)	5.34 (13.55)
PITCH	DEGREES	7.85	7.93	7.51
PITCH RATE	DEGREES PER SEC	30.76	30.47	28.37
ROLL	DEGREES	6.67	6.57	6.30
ROLL RATE	DEGREES PER SEC	27.78	25.40	23.16
HEAVE ACCELERATION	G'S	0.177	0.174	0.167
CABIN ACCELERATION	G'S	0.226	0.225	0.209

TABLE 17b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	8.07 (20.49)	7.33 (18.61)
HEAVE	INCHES (CM)	6.53 (16.58)	6.25 (15.88)
PITCH	DEGREES	11.34	11.71
PITCH RATE	DEGREES PER SEC	55.87	61.12
ROLL	DEGREES	8.74	8.02
ROLL RATE	DEGREES PER SEC	39.86	35.58
HEAVE ACCELERATION	G'S	0.295	0.281
CABIN ACCELERATION	G'S	0.342	0.342

TABLE 18

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 30 DEGREE HEADING FROM PHASE 2

TABLE 18a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	6.47 (16.44)	6.73 (17.11)	6.26 (15.91)
HEAVE	INCHES (CM)	5.16 (13.10)	5.84 (14.83)	4.81 (12.22)
PITCH	DEGREES	11.72	11.38	10.19
PITCH RATE	DEGREES PER SEC	53.60	54.20	46.64
ROLL	DEGREES	5.26	5.20	4.87
ROLL RATE	DEGREES PER SEC	21.46	21.35	19.40
HEAVE ACCELERATION	G'S	0.142	0.132	0.130
CABIN ACCELERATION	G'S	0.323	0.310	0.278

TABLE 18b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	10.98 (27.90)	11.84 (30.07)	11.03 (28.02)
HEAVE	INCHES (CM)	9.09 (23.08)	10.52 (26.73)	10.72 (27.22)
PITCH	DEGREES	13.89	15.30	15.34
PITCH RATE	DEGREES PER SEC	58.88	69.90	67.10
ROLL	DEGREES	6.68	7.14	7.08
ROLL RATE	DEGREES PER SEC	25.17	26.46	26.19
HEAVE ACCELERATION	G'S	0.193	0.201	0.186
CABIN ACCELERATION	G'S	0.344	0.385	0.395

TABLE 18c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	16.15 (41.03)	14.96 (38.01)
HEAVE	INCHES (CM)	15.39 (39.08)	13.85 (35.17)
PITCH	DEGREES	16.40	16.14
PITCH RATE	DEGREES PER SEC	74.82	65.38
ROLL	DEGREES	7.92	8.17
ROLL RATE	DEGREES PER SEC	31.60	27.76
HEAVE ACCELERATION	G'S	0.252	0.233
CABIN ACCELERATION	G'S	0.433	0.423

TABLE 19

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES
OF MODEL RESPONSE AT ZERO SPEED
AND 0 DEGREE HEADING FROM PHASE 2

TABLE 19a - SEA STATE 2

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	6.04 (15.33)	5.94 (15.09)	5.89 (14.97)
HEAVE	INCHES (CM)	4.73 (12.02)	4.76 (12.08)	4.53 (11.50)
PITCH	DEGREES	11.23	11.10	10.78
PITCH RATE	DEGREES PER SEC	49.38	48.87	47.96
HEAVE ACCELERATION	G'S	0.126	0.117	0.132
CABIN ACCELERATION	G'S	0.309	0.297	0.294

TABLE 19b - SEA STATE 3

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	10.78 (27.39)	11.23 (28.52)	11.48 (29.16)
HEAVE	INCHES (CM)	9.72 (24.69)	10.37 (26.35)	10.42 (26.46)
PITCH	DEGREES	16.04	16.98	13.99
PITCH RATE	DEGREES PER SEC	70.77	73.56	60.31
HEAVE ACCELERATION	G'S	0.194	0.199	0.176
CABIN ACCELERATION	G'S	0.426	0.424	0.358

TABLE 19c - SEA STATE 4

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	15.32 (38.91)	16.16 (41.06)
HEAVE	INCHES (CM)	14.05 (35.68)	15.10 (38.36)
PITCH	DEGREES	18.87	19.24
PITCH RATE	DEGREES PER SEC	77.12	80.71
HEAVE ACCELERATION	G'S	0.243	0.252
CABIN ACCELERATION	G'S	0.455	0.503

TABLE 20

SUMMARY OF SIGNIFICANT DOUBLE AMPLITUDES OF MODEL RESPONSE AT ZERO SPEED IN CONFUSED SEAS

TABLE 20a

SEA STATE 2 FROM AHEAD AND SWELL WITH 12.6 FT (3.8 M) WAVE LENGTH FROM ABEAM

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	7.53 (19.25)	7.81 (19.84)	7.83 (19.89)
HEAVE	INCHES (CM)	4.72 (11.99)	4.84 (12.29)	4.77 (12.12)
PITCH	DEGREES	9.26	10.73	9.13
PITCH RATE	DEGREES PER SEC	41.31	47.88	40.59
ROLL	DEGREES	5.82	7.72	6.62
ROLL RATE	DEGREES PER SEC	14.54	17.49	14.54
HEAVE ACCELERATION	G'S	0.166	0.180	0.170
CABIN ACCELERATION	G'S	0.309	0.348	0.306

TABLE 20b

SEA STATE 2 FROM AHEAD AND SWELL WITH 30.0 FT (9.1 M) WAVE LENGTH FROM ABEAM

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	7.86 (19.96)	8.88 (22.56)	8.16 (20.73)
HEAVE	INCHES (CM)	6.04 (15.34)	7.24 (18.39)	6.35 (16.13)
PITCH	DEGREES	10.25	10.37	10.29
PITCH RATE	DEGREES PER SEC	46.05	45.40	47.44
ROLL	DEGREES	8.44	8.20	8.70
ROLL RATE	DEGREES PER SEC	16.40	14.09	13.63
HEAVE ACCELERATION	G'S	0.146	0.156	0.147
CABIN ACCELERATION	G'S	0.326	0.316	0.341

TABLE 20c

SEA STATE 3 FROM AHEAD AND SWELL WITH 12.6 FT (3.8 M) WAVE LENGTH FROM ABEAM

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	10.60 (26.92)	12.26 (31.14)	12.43 (31.57)
HEAVE	INCHES (CM)	9.43 (23.95)	9.84 (24.99)	9.80 (24.89)
PITCH	DEGREES	16.29	15.24	14.56
PITCH RATE	DEGREES PER SEC	72.83	66.76	62.62
ROLL	DEGREES	8.56	8.44	8.45
ROLL RATE	DEGREES PER SEC	20.76	21.04	17.96
HEAVE ACCELERATION	G'S	0.224	0.234	0.229
CABIN ACCELERATION	G'S	0.505	0.477	0.446

TABLE 20 - CONCLUDED

TABLE 20d

SEA STATE 3 FROM AHEAD AND SWELL WITH 30.0 FT (9.1 M) WAVE LENGTH FROM ABEAM

MEASUREMENT	UNITS	NO DAMPING PLATES	SMALL DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	12.98 (32.97)	12.32 (31.29)	13.69 (34.77)
HEAVE	INCHES (CM)	10.20 (25.91)	10.67 (27.10)	10.79 (27.41)
PITCH	DEGREES	15.34	15.32	13.67
PITCH RATE	DEGREES PER SEC	67.25	66.19	59.16
ROLL	DEGREES	9.57	9.63	9.26
ROLL RATE	DEGREES PER SEC	17.70	17.53	15.04
HEAVE ACCELERATION	G'S	0.204	0.204	0.190
CABIN ACCELERATION	G'S	0.457	0.448	0.413

TABLE 20e

SEA STATE 4 FROM AHEAD AND SWELL WITH 12.6 FT (3.8 M) WAVE LENGTH FROM ABEAM

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	15.53 (39.45)	15.03 (38.18)
HEAVE	INCHES (CM)	13.55 (34.42)	13.54 (34.39)
PITCH	DEGREES	18.64	18.64
PITCH RATE	DEGREES PER SEC	74.64	72.43
ROLL	DEGREES	10.57	8.57
ROLL RATE	DEGREES PER SEC	27.33	19.13
HEAVE ACCELERATION	G'S	0.282	0.271
CABIN ACCELERATION	G'S	0.574	0.521

TABLE 20f

SEA STATE 4 FROM AHEAD AND SWELL WITH 30.0 FT (9.1 M) WAVE LENGTH FROM ABEAM

MEASUREMENT	UNITS	NO DAMPING PLATES	LARGE DAMPING PLATES
WAVE HEIGHT	INCHES (CM)	15.70 (39.88)	16.62 (42.21)
HEAVE	INCHES (CM)	15.13 (38.43)	15.16 (38.51)
PITCH	DEGREES	19.57	18.06
PITCH RATE	DEGREES PER SEC	81.55	72.44
ROLL	DEGREES	10.57	10.36
ROLL RATE	DEGREES PER SEC	19.51	17.82
HEAVE ACCELERATION	G'S	0.268	0.238
CABIN ACCELERATION	G'S	0.595	0.490

TABLE A1

PRINCIPAL CHARACTERISTICS OF BUOY MODEL

	WEIGHT AT CENTER		WEIGHT AT OUTSIDE	
	ENGLISH	METRIC	ENGLISH	METRIC
OUTSIDE DIAMETER	6.5 FEET	1.98 METERS	6.5 FEET	1.98 METERS
INSIDE DIAMETER	6.0 FEET	1.83 METERS	6.0 FEET	1.83 METERS
DEPTH	1.33 FEET	0.41 METER	1.33 FEET	0.41 METER
WEIGHT	250.0 POUNDS	113.4 KGS	250.0 POUNDS	113.4 KGS
VERTICAL LOCATION OF CG, ABOVE BASELINE	2.07 FEET	0.63 METER	0.98 FEET	0.30 METER
MOMENT OF INERTIA ABOUT DIAMETER	11.5 SLUG-FT^2	15.59 KG-M^2	37.1 SLUG-FT^2	50.31 KG-M^2
NATURAL PERIOD FOR OSCILLATION ABOUT DIAMETER	2.4 SECONDS	2.4 SECONDS	2.4 SECONDS	2.4 SECONDS
HEAVE NATURAL PERIOD	1.1 SECONDS	1.1 SECONDS	1.1 SECONDS	1.1 SECONDS
SCALE RATIO FOR RANDOM WAVE RUNS	1 : 7.5	1 : 7.5	1 : 7.5	1 : 7.5

TABLE A2

SUMMARY OF STANDARD DEVIATION VALUES
FOR BUOY IN VARIOUS SEA STATES

MEASUREMENT	UNITS	BALLAST AT CENTER SEA STATE*			BALLAST AT OUTSIDE SEA STATE*		
		2	3	4	2	3	4
WAVE HEIGHT	INCHES (CM)	1.23 (3.15)	1.69 (4.28)	2.92 (7.42)	1.60 (4.07)	2.07 (5.25)	2.98 (7.57)
HEAVE	INCHES (CM)	0.83 (2.11)	1.31 (3.32)	2.46 (6.24)	1.04 (2.63)	1.50 (3.81)	2.44 (6.21)
PITCH	DEGREES	1.81	2.49	4.12	2.11	2.71	3.97
PITCH RATE	DEGREES PER SEC	4.50	6.32	9.43	5.61	7.02	9.69
HEAVE ACCELERATION	G'S	0.024	0.031	0.054	0.029	0.037	0.050

* Scale Ratio = 7.5

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